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Geology of

Carbonatite – Alkalic Rock Complexes in Ontario:

Nagagami River Alkalic Rock Complex

District of Cochrane

Ontario Geological Survey
Study 43

by R. P. Sage

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Foreword

The Nagagami River Alkalic Rock Complex was examined as part of a project to study alkalic rock – carbonatite complexes in Ontario. The study describes the rock types and mineralogy of the complex and outlines the history of the mineral exploration efforts within the complex.

V.G. Milne

Director
Ontario Geological Survey

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Conversion from SI to Imperial			Conversion from Imperial to SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
		LENGTH			
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
		AREA			
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
		VOLUME			
1 cm^3	0.061 02	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.308 0	cubic yards	1 cubic yard	0.764 555	m^3
		CAPACITY			
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
		MASS			
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
		CONCENTRATION			
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight per ton (short)	0.05	ounces (troy) per ton (short)

***Note:** Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries, published by the Mining Association of Canada in cooperation with the Coal Association of Canada.*

Geology of
Carbonatite – Alkalic Rock Complexes in Ontario:
Nagagami River Alkalic Rock Complex
District of Cochrane

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1. Geologist, Precambrian Geology Section, Ontario Geological Survey, Toronto. Manuscript approved for publication by John Wood, Chief Geologist, Ontario Geological Survey, June, 1983.

This report is published with the permission of V.G. Milne, Director, Ontario Geological Survey.

Abstract

The Nagagami River Alkalic Rock Complex lies beneath swamp, muskeg, glacial till, and Paleozoic rocks of the James Bay Lowlands. The complex is unexposed and all descriptive data concerning this complex came from the limited number of samples available from diamond drilling. Aeromagnetic data indicate that the complex consists of two ring-shaped subcomplexes. The aeromagnetic pattern of the southern subcomplex cuts that of the northern subcomplex, suggesting that the southern subcomplex is younger. Linear northwest-trending aeromagnetic patterns attributed to diabase dikes do not cross the aeromagnetic pattern of the alkalic rock complex, suggesting that these dikes are cut by the alkalic rocks and thus are older. This observation, combined with the fresh unmetamorphosed nature of the rock, suggests to the author that the complex is likely of Late Precambrian age, equivalent to the dominant period of alkalic magmatism in Ontario. Regional structures that control the emplacement of the subcomplexes have not been clearly identified but the complex lies on trend with the extension of the northeast-striking Gravel River Fault.

The dominant rock type is an amphibole-pyroxene syenite which varies from fine to coarse grained, and locally displays a trachytoidal texture. A coarse-grained nepheline-bearing phase appears restricted to the southern subcomplex. A very coarse-grained pegmatitic phase and a minor granite phase have also been identified. Petrographically, the Nagagami River Alkalic Rock Complex has strong similarities to the pyroxene-bearing syenites of the Port Coldwell Alkalic Rock Complex.

The intrusion underwent unsuccessful testing for iron and niobium in 1964 by the Algoma Ore Properties Division of Algoma Steel Corporation. Future exploration of the complex should be directed towards the type of mineralization found in equivalent syenitic rocks of the Port Coldwell Alkalic Rock Complex.

Résumé

Le complexe rocheux alcalin de la rivière Nagagami est situé sous les terres marécageuses, la fondrière, la moraine et les roches paléozoiques des plaines littorales de la baie James. Il n'affleure pas la surface et les données descriptives recueillies jusqu'à présent proviennent des quelques échantillons prélevés par forage au diamant. Les données aéromagnétiques indiquent que le complexe est formé de deux sous-complexes annulaires. La structure aéromagnétique du sous-complexe sud traverse celle du sous-complexe nord, ce qui semble indiquer que le sous-complexe sud est moins âgé. Les structures aéromagnétiques linéraires orientées vers le nord-ouest associées aux dykes de diabase ne traversent pas la structure aéromagnétique du complexe rocheux alcalin, ce qui semble indiquer que ces dykes sont coupés par les roches alcalines et que, par conséquent ils sont plus âgés. D'après cette observation et puisque la roche n'est pas métamorphosée, l'auteur estime que le complexe date probablement du Précambrien supérieur, soit d'un âge équivalent à la période dominante du magmatisme alcalin en Ontario. Les structures régionales qui régissent l'emplacement des sous-complexes n'ont pas été clairement identifiées mais le complexe est situé dans le prolongement de la faille de la rivière Gravel, qui est orientée vers le nord-est.

Le principal type de roche est la syénite pyroxène amphibole à grain fin et à gros grain et dont la texture locale est trachytoide. Il semble que la phase contenant de la néphéline à gros grain ne soit présente que dans le complexe sud. Il existe également une phase pegmatitique à très gros grain et une petite phase de granite. Sur le plan pétrographique, le complexe rocheux alcalin de la rivière Nagagami ressemble considérablement aux syénites contenant du pyroxène que l'on trouve dans le complexe rocheux alcalin Port Coldwell.

En 1964, Algoma Ore Properties n'a pas relevé la présence de fer et de niobium dans l'intrusion. Les prospections futures devraient porter sur le type de minéralisation identifié dans des roches syénitiques semblables provenant du complexe rocheux alcalin Port Coldwell.

Geology of Carbonatite – Alkalic Rock Complexes in Ontario: Nagagami River Alkalic Rock Complex, District of Cochrane, by R.P. Sage. Ontario Geological Survey, Study 43, 48p. Published 1988. ISBN 0–7729–0578–9.

Introduction

The Nagagami River Alkalic Rock Complex lies beneath Paleozoic rocks of the James Bay Lowlands. The outline of the intrusion was indicated by government aeromagnetic surveys (ODM–GSC 1967), but its presence was first detected by aeromagnetic surveys completed by the Algoma Ore Properties Division of Algoma Steel Corporation. Beginning in 1961 and continuing until 1964, Algoma Ore Properties conducted geophysical surveys over the area, followed by a limited diamond drilling program which failed to encounter mineralization of economic interest.

Acknowledgments

The present report is based on several specimens of core obtained from the Resident Geologist's office in Timmins and several specimens loaned to the Ministry by Mr. J. Huddart, Exploration Manager, Algoma Steel Corporation. During the 1979 field season, the author travelled by float–equipped aircraft from the Ontario Ministry of Natural Resources airbase at Cary Lake to the former camp site of Algoma Ore Properties on "Ping" Lake (local name). The author obtained core samples from the largely decomposed core boxes at the former camp site. Mr. E. Sagle, geological assistant, aided the author in sampling, and Mr. B. Luwe, pilot, flew the author to the site. In 1988, Mr. A. Lisowyk recalculated statistics on the chemical data obtained for the lithologic units.

Location and Access

The Nagagami River Alkalic Rock Complex (Figure 1) is located 65 km northwest of Hearst and about 6.5 km southwest of the junction of the Nagagami and Otasawain Rivers. The complex lies 32 km north of the Canadian National rail line. The centre of the complex is located at approximately 50°10'N Latitude and 89°15'W Longitude.

Access to the area is by float–equipped aircraft and all–terrain vehicle. The author flew in aircraft of the Ontario Ministry of Natural Resources from Cary Lake to "Ping" Lake located near the complex. The distance is approximately 50 km.

Physiography

The terrain is wet or swampy and has low relief. The less swampy areas are wooded.

Field Methods and Laboratory Techniques

Portions of the complex lie beneath Paleozoic rocks and other areas are covered by glacial drift, thus the body is not amenable to field study. All information must be obtained by drilling and all rock specimens examined during this project were from the diamond drill core obtained by Algoma Ore Properties, during their 1964 drill program.

Thin sections were prepared from the available specimens and small but representative samples were submitted for complete rock analysis. Considering that the complex is large and the number of sample points is small, the rock types observed may not be representative of all rock types present in the body.

Previous Geologic Work

Venn (1964?) prepared a brief report describing the work completed by Algoma Ore Properties.

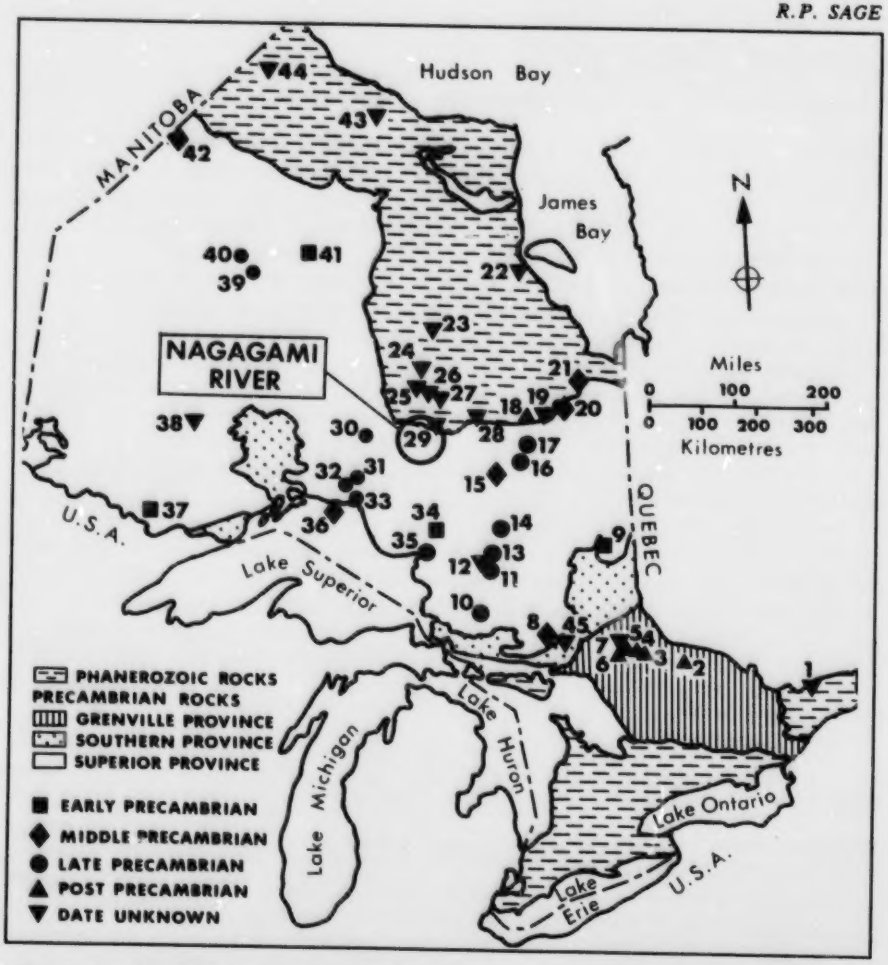

Figure 1. *Key map showing location of carbonatite – alkalic rock complexes in Ontario.*

1. *Eastview*
2. *Brent*
3. *Callander B.*
4. *Manitou Is.*
5. *Burritt Is.*
6. *Iron Is.*
7. *Lavergne*
8. *Spanish R.*
9. *Otto Stock*
10. *Seabrook L.*
11. *Lackner L.*
12. *Borden Tp.*
13. *Nemegosenda L.*
14. *Shenango Tp.*
15. *Cargill Tp.*
16. *Teetzel Tp.*
17. *Clay-Howells*
18. *Hecla-Kilmer*
19. *Valentine Tp.*
20. *Goldray*
21. *Argor*
22. *Lawashi R.*
23. *Poplar R.*
24. *Albany Forks*
25. *L. Drowning R.*
26. *Kingfisher R. West*
27. *Kingfisher R. East*
28. *Martison L.*
29. **Nagagami R.**
30. *Chipman L. (dikes)*
31. *Killala L.*
32. *Prairie L.*
33. *Port Coldwell*
34. *Herman L.*
35. *Firesand R.*
36. *Slate Is.*
37. *Poohbah L.*
38. *Sturgeon Narrows & Squaw L.*
39. *Schryburt L.*
40. *Big Beaver House*
41. *Wapikopa L.*
42. *"Carb" L.*
43. *Gooseberry Br.*
44. *Niskibi L.*
45. *Nemag L. & Lusk L.*

General Geology

The Nagagami River Alkalic Rock Complex is likely composed of two ring–shaped subcomplexes with more mafic rims and more leucocratic cores. The lithologic phases examined by the author range from biotite granite to melanocratic syenite (Table 1). Drill logs of Algoma Ore Properties Division of Algoma Steel Corporation described lithologies ranging from diorite to syenite (Assessment Files Research Office, Ontario Geological Survey, Toronto).

On the basis of aeromagnetic data, Algoma Ore Properties interpreted the presence of two circular structures (Figures 2 and 3). The north structure is approximately 13 km in diameter (north subcomplex) and the south subcomplex is approximately 5 km in diameter. These anomalies have surface areas of approximately 130 km^2, and 20 km^2, respectively. The samples examined by the author from holes 1 through 7 are from the north subcomplex, and those from holes 8 and 9 are from the smaller, south subcomplex. All but one of the specimens were classified as syenite.

The north subcomplex appears to consist mainly of magnetite–bearing, amphibole–pyroxene syenite; the south subcomplex, in addition to amphibole–pyroxene syenite, contains a nepheline syenite phase.

The north subcomplex lies beneath 143 to 201 m of overburden and Paleozoic rocks (Table 2). The south subcomplex is overlain by 15 to 84 m of overburden and Paleozoic rocks. The overlying rocks are mainly fractured limestone, but limey sandstone, mudstone, limestone, quartz sandstone, and siltstone are also listed on the drill logs.

The author believes that the north subcomplex is likely of Late Precambrian age on the basis of its lack of metamorphism and its apparent cross–cutting relationship with northwest–trending diabase dikes. The south subcomplex likely is a

TABLE 1. TABLE OF LITHOLOGIC UNITS FOR THE NAGAGAMI RIVER ALKALIC ROCK COMPLEX.

CENOZOIC

Recent

Swamp and stream deposits.

Pleistocene

Glacial deposits.

Unconformity

PALEOZOIC

Limestone, limey sandstone, mudstone, quartz sandstone, siltstone.

Unconformity

LATE PRECAMBRIAN

Nagagami River Alkalic Rock Complex

Biotite granite; pegmatitic syenite; nepheline–bearing biotite–amphibole syenite; coarse–grained trachytoidal amphibole–pyroxene syenite; coarse–grained biotite–amphibole–pyroxene syenite; medium–grained biotite–amphibole–pyroxene syenite; melanocratic amphibole–pyroxene syenite.

Intrusive contact

MIDDLE TO LATE PRECAMBRIAN

Diabase dikes (?)

Intrusive contact

EARLY PRECAMBRIAN

Granitic migmatite, metavolcanics and metasediments (?)

TABLE 2. OVERBURDEN AND PALEOZOIC THICKNESS ABOVE THE NAGAGAMI RIVER ALKALIC ROCK COMPLEX (FROM DRILL LOGS OF ALGOMA ORE PROPERTIES).

	Overburden		Paleozoic Rocks		Total
Hole	feet	metres	feet	metres	metres
1-64	34	10.4	635.5	193.7	204.1
2-64	AB	AB			
3-64	110	33.5	AB		
4-64	127	38.7	350.5	106.8	145.5
5-64	90	27.4	382	116.4	143.8
6-64	65	19.8	455	138.7	158.5
7-64	65	19.8	466	142.0	161.8
8	50	15.2	230	70.1	85.3
9	50	15.2	0	0	15.2

AB = abandoned.
Average overburden: 73.9 feet (22.5 m)
Average thickness of Paleozoic rocks: 359.9 feet (109.7 m)

younger intrusion of the same age, emplaced into the larger body, since its isomagnetic contours appear to truncate those of the north subcomplex. The Nagagami River complex is likely somewhat analogous to the Port Coldwell Alkalic Rock Complex, which consists of three ring complexes superimposed on each other (Currie 1980). The Nagagami River complex appears to be, on the basis of a much more regular aeromagnetic pattern, less variable in lithology. The emplacement of the complex was likely structurally controlled, but there is insufficient data on which to base an interpretation as to the nature or attitude of this structure. The intrusion lies on trend with the extrapolated extension of the regional, northeast-striking Gravel River Fault.

The Nagagami River circular magnetic anomaly is one of several within the region of the Albany River that has been interpreted as being due to alkalic rock–carbonatite intrusions (Satterly 1970).

LATE PRECAMBRIAN (PROTEROZOIC)

NAGAGAMI RIVER ALKALIC ROCK COMPLEX

On the basis of major mineralogy and texture, the lithologies of the Nagagami River Alkalic Rock Complex appear to the author to be similar to some of the syenite phases of the Port Coldwell Alkalic Rock Complex. The north subcomplex is predominantly a silica–saturated magnetite–bearing pyroxene syenite. The south subcomplex contains biotite–amphibole–nepheline syenite and is thus a silica–undersaturated body. Both subcomplexes are likely related to the same petrologic system and are likely closely related in time as are the three ring complexes composing the Port Coldwell Alkalic Rock Complex (Currie 1980).

Melanocratic Amphibole–Pyroxene Syenite

Rocks falling into this group appear to be restricted to the north subcomplex and are equivalent to the "diorite" recorded on the diamond drill logs of Algoma Ore Properties. The samples come from drill holes 4, 5 and 7.

Figure 2. *Aeromagnetic map of the Nagagami River Alkalic Rock Complex (from Vann 1964?).*

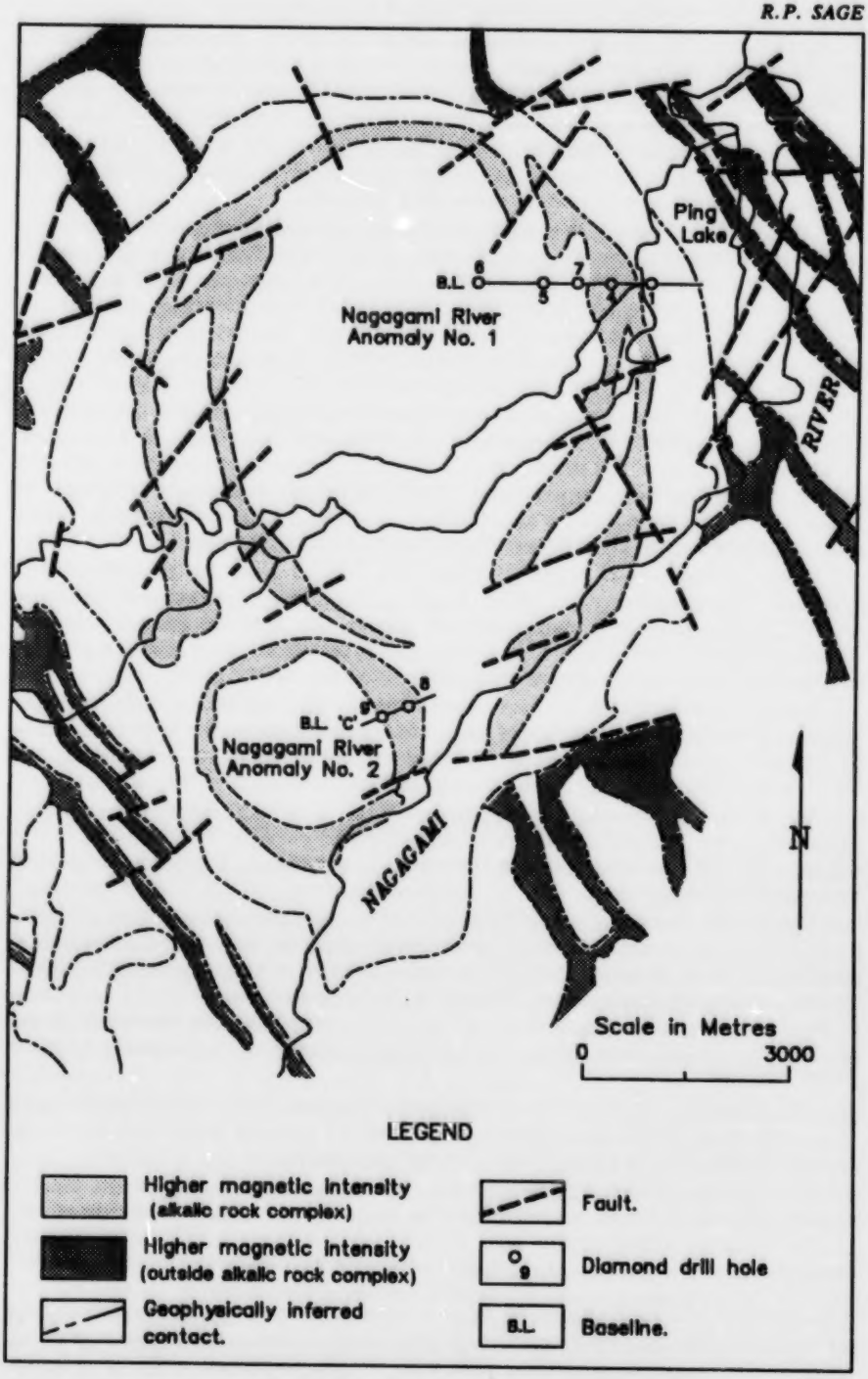

Figure 3. *Geology of the Nagagami River Alkalic Rock Complex, interpreted from aeromagnetic data. From Venn (1964?).*

In thin section, the rock is fine to medium grained, equigranular, massive, allotriomorphic with curved grain boundaries. One section is hypidiomorphic, while serrate to lobate grain boundaries were noted in two samples.

The mode is estimated as 1 to 40% clinopyroxene, 5 to 30% amphibole, 0 to 5% biotite, trace to 20% opaques, 0 to 10% microcline, 0 to 10% plagioclase (An 6–8), and 30 to 70% perthite. Trace to minor amounts of zircon, apatite, quartz and garnet are present in one or more thin sections.

Clinopyroxene occurs as anhedral to rarely subhedral grains. The grains are commonly round and have been replaced by amphibole. The pyroxene is colourless to very pale green and occasionally encloses an opaque grain of magnetite. The clinopyroxene has also undergone alteration to an unidentified brown mineral(s). This brown alteration is commonly spatially associated with amphibole alteration of the pyroxene. The amphibole alteration has generally occurred along the edge of the crystal. Rare schiller structure was noted in one thin section.

Amphibole is anhedral and occurs as pleochroic grains ranging from colourless to pale green and from brown to green–brown. Amphibole is a common breakdown product of the pyroxene and occurs along the edges of grains and as a patchy replacement of the pyroxene. The amphibole occasionally encloses an opaque grain of magnetite. Some interstitial amphibole is probably primary while other amphibole is likely a breakdown product of the pyroxene.

Biotite forms brown anhedral grains interlocked with the amphibole and pyroxene. The grains may be ragged or tabular. In one instance, a grain of biotite is poikilitically enclosed in clinopyroxene. Biotite also encloses opaque grains of magnetite. The biotite is likely both primary (large tabular grains) and the result of the breakdown of the pyroxene and amphibole.

The opaque is probably magnetite. It occurs as anhedral rounded to subrounded grains and occurs in close association with the other mafic phases. Some of the opaques are likely breakdown products of the other mafic minerals but some occur interstitially and are possibly primary in origin.

Minor albitic plagioclase is present but it has generally undergone extensive replacement by potassium feldspar to form a patch perthite. On the basis of the relative ratio of potassium feldspar to plagioclase feldspar, the patch perthite is commonly an antiperthite.

The perthite is anhedral in form and generally forms tabular grains. String perthite is dominant over patch perthite and often displays Carlsbad twinning. Perthitic textures in some samples can be seen only at very high magnification. Several specimens display some fracturing of the grains suggesting the possibility of an incipient protoclastic texture. Pericline twinning is locally present on some of the albitic plagioclase which has undergone potassium replacement to form patch perthite.

The presence of quartz in one sample and garnet in a second could suggest that some rocks of this suite have been contaminated by the assimilation of wall rock inclusions and are therefore of mixed parentage.

The accessory magnetite in this lithology is the likely cause of the ring of higher magnetic intensity that outlines the shape of this alkalic rock complex.

Medium-Grained Biotite-Amphibole-Pyroxene Syenite

Specimens of this unit appear to be restricted to core from diamond drill hole number 4 of Algoma Ore Properties. In thin section, the rock is medium grained, equigranular, massive, allotriomorphic with straight to serrate grain boundaries. The mode is estimated to be 1 to 20% clinopyroxene, 0 to 20% amphibole, 0 to 15% biotite, 2 to 20% opaques, 0 to 45% plagioclase (An 8–12), and 55 to 80% perthite.

Clinopyroxene is colourless to pale green and has undergone extensive alteration to fine-grained biotite and amphibole along edges and fractures. The clinopyroxene poikilitically encloses an occasional opaque grain of magnetite. The amphibole alteration, in places, consists of fibrous green crystals.

Amphibole is anhedral and brown to green-brown in colour. The amphibole commonly occurs as a replacement along edges and as patches within clinopyroxene.

Biotite is generally fine grained and replaces clinopyroxene. It more rarely forms tabular brown to red-brown grains in association with the other mafic minerals. The tabular grains may be primary biotite.

The opaque mineral is likely magnetite and it forms anhedral, sometimes interstitial grains. It commonly is associated with the other mafic minerals and it is, in part, likely a breakdown product of some of these minerals. Some of the more clearly interstitial opaque minerals are likely primary in origin. Opaques poikilitically enclosed in pyroxene and opaques enclosing feldspar have been observed. A very fine-grained narrow rim of biotite may enclose the opaques in some thin sections.

Albitic plagioclase has undergone extensive replacement by potassium feldspar to form patch antiperthite. Some plagioclase appears broken and fractured, and thus is protoclastic in texture. Minor pericline twinning of the plagioclase was observed.

Perthite consists of two types: string perthite, and patch perthite. The string perthite is dominant and the crystals are anhedral. Some of the feldspars are turbid and others very fresh in appearance. Carlsbad twinning is present in the string perthite grains. Some grains display a perthitic texture only at high magnification. Feldspar-feldspar grain boundaries vary from straight to serrate.

On the basis of the position of drill hole 4, the accessory magnetite in this unit has contributed to the zone of higher magnetic intensity that outlines the shape of the Nagagami River Alkalic Rock Complex.

Coarse-Grained Biotite-Amphibole-Pyroxene Syenite

Samples of this rock group came from holes 4 and 7 on the north subcomplex and from hole 8 on the south subcomplex. In thin section, the rock is coarse grained, massive, equigranular, allotriomorphic with curved grain boundaries. Rarely does the texture approach hypidiomorphic. The mode is estimated to be 0 to 20% clinopyroxene, 0 to 20% amphibole, 0 to 10% opaques, 0 to 20% biotite, and 60 to 95% perthite. The plagioclase occurs as part of a patch perthite resulting from potassium replacement of albite and has a composition of An 4–10.

Trace to minor amounts of apatite, carbonate, olivine, epidote, zircon, and fluorite are present in one or more thin sections.

Clinopyroxene is anhedral to subhedral in outline and colourless to pale green. The pyroxene occurs interstitial to the feldspar and commonly has undergone alteration to amphibole. It also poikilitically encloses the occasional opaque grain of magnetite. The amphibole derived from the pyroxene is green in colour and is associated with minor amount of carbonate and biotite. One thin section contains several grains with schiller texture. The clinopyroxene grains in several samples appear to be mildly fractured.

Amphibole is pleochroic from green-brown to dark green and may enclose minor relict pyroxene. The amphibole commonly mantles pyroxene and can generally be interpreted to be the product of pyroxene breakdown. Amphibole may occur as acicular green grains on some of the altered pyroxene.

The opaques are most probably magnetite. The grains are rounded to subrounded and anhedral in form. The opaques are closely associated with the other mafic minerals and may, in part, be a breakdown product of them. Some

opaques are interstitial and possibly primary in origin. The opaque mineral is poikilitically enclosed in pyroxene and amphibole and rarely poikilitically encloses an apatite grain. The magnetite commonly displays a narrow rim of very fine–grained biotite which in places is closely associated and interlocked with subordinate amounts of very fine–grained acicular amphibole.

Biotite is common as a fine–grained reaction product that forms the margins of opaque grains, possibly by reaction with late stage magmatic fluids. It also occurs as a fine–grained breakdown product of both pyroxene and amphibole. Biotite is also present as anhedral, ragged to tabular, interstitial brown grains. Some of these grains are probably primary in origin. One biotite grain in one thin section is zoned from a pale yellow–brown core to a dark red–brown rim.

Trace amounts of olivine occur in a number of sections. The olivine is altered to red–brown iddingsite, talc, magnetite and chlorite. The outline of the former olivine grains is anhedral.

Feldspar consists of patch and string perthite. The patch perthite has resulted from potassium feldspar replacement of albitic plagioclase. String perthite is the dominant perthite and often displays Carlsbad twinning. The feldspar grains are anhedral, tabular, and generally fresh in appearance. Some occasional fracturing of the feldspar grains is present and the string perthite occasionally contains an angular fragment of plagioclase. In those samples displaying some alteration, minor amounts of sericite are present, but other feldspar alteration products are also likely present. Some of the alteration appears to have been crudely controlled by the cleavage of the feldspar. One feldspar grain encloses a grain of magnetite.

The accessory magnetite content of this lithology has also contributed to the zone of higher magnetic intensity that outlined the Nagagami River Alkalic Rock Complex.

Coarse–Grained Trachytoidal Amphibole–Pyroxene Syenite

A number of samples from holes 4 and 7 of Algoma Ore Properties display a well developed trachytoidal texture due to the orientation of tabular feldspars. The samples are coarse grained and are considered to be equivalent to the non–trachytoidal coarse–grained biotite–amphibole–pyroxene syenite. The relationship of the trachytoidal syenite to the non–trachytoidal syenite is unclear and is thus discussed separately. Additional work may suggest incorporating this unit with the coarse–grained biotite–amphibole–pyroxene syenite. The author interprets the texture to have resulted from flow in a partially crystallized syenite magma.

In thin section, rocks of this group are coarse grained, massive, equigranular, trachytoidal, hypidiomorphic with straight to serrate grain boundaries. Rarely, the rock tends to be allotriomorphic.

The mode is estimated to be 10 to 20% clinopyroxene, 5 to 10% amphibole, 0 to 3% biotite, 1 to 5% opaques, 0 to 15% plagioclase (An 4–8), and 60 to 80% perthite. A trace amount of apatite is present and two samples contain minor altered olivine.

Clinopyroxene occurs as anhedral to subhedral colourless to pale green grains. The pyroxene occurs as an aggregate of grains interstitial to the feldspar. The pyroxene has undergone alteration to amphibole along the edge of the grains and in patches throughout the grain. The clinopyroxene may poikilitically enclose a rare grain of magnetite. The opaque inclusions are present in several pyroxene grains within several sections. The opaque inclusions occur in two sets which are subparallel in orientation and elongate in outline.

Amphibole forms anhedral green–brown to green grains that commonly have replaced clinopyroxene. On occasion, the amphibole encloses relict grains of pyroxene.

Biotite occurs in very minor amounts as anhedral brown grains and is closely associated with opaques and other mafic minerals.

The opaques are anhedral and are likely magnetite. The opaques are closely associated with pyroxene and amphibole and may occur poikilitically enclosed in pyroxene. The opaques enclose the occasional pyroxene or apatite grain. Narrow rims on the opaques are common, consisting of very fine-grained amphibole and possibly some biotite. Some of the opaques are interstitial and possibly primary in origin, while other opaques likely formed by the breakdown or reaction of the mafic minerals with late-stage magmatic fluids.

Feldspar consists of string and patch perthite. The dominant feldspar texture is string perthite. The quadrille twinning of microcline was observed in several samples but it is present in only minor quantities. The perthite is anhedral to subhedral in form and Carlsbad twinning is restricted to string perthite. The subordinate patch perthite appears to result from potassium feldspar replacement of albitic plagioclase. Minor pericline twinning was noted in the plagioclase. The feldspar is generally fresh, but is turbid in several samples. This turbidity likely reflects extremely fine-grained alteration of the feldspar.

The minor amount of olivine present in two samples occurs as round, anhedral grains, with brown alteration along the margins and internal fractures within the grains. The author expects the olivine to be a high-iron variety which is characteristic of olivine occurring in alkalic plutonic rocks (Deer *et al.* 1962).

Nepheline-Bearing Biotite-Amphibole Syenite

Nepheline-bearing rocks appear to be restricted to diamond drill hole 9 of Algoma Ore Properties, on the south subcomplex.

In thin section, the nepheline-bearing phase is coarse grained, massive, allotriomorphic to hypidiomorphic with straight to lobate grain boundaries. The grain boundaries are dominantly curved. The presence of former nepheline is easily identified in the drill core by its typically dark red-brown colour and somewhat waxy appearance. An X-ray diffraction pattern of the red altered mineral gives a pattern for hydronephelite (Geoscience Laboratories, Ontario Geological Survey). The mineral appears similar to red hydronephelite observed by the author in outcrops of the Port Coldwell Alkalic Rock Complex and in drill core from the Hecla-Kilmer Alkalic Rock Complex.

The mode is estimated to be 0 to 10% biotite, 0 to 20% amphibole, 0 to 3% opaques, 1 to 15% hydronephelite, and 70 to 85% perthite. Trace amounts of apatite, carbonate, clinopyroxene, fluorite and epidote are present in one or more thin sections.

Biotite forms brown tabular grains that form interlocking aggregates with each other and with amphibole. Biotite forms narrow rims on the opaques, and traces of chlorite alteration of the biotite were observed in one sample.

Amphibole is anhedral, interstitial and displays very minor alteration to biotite and chlorite. The amphibole is brown to green-brown in colour and encloses small feldspar grains.

The opaque is likely magnetite and occurs closely associated with the other mafic minerals. It may, in some instances, be a breakdown product of the other mafic minerals, but it is likely to be a primary phase in most cases. The opaques are anhedral, interstitial, round to subrounded in form.

Interstitial to the feldspars are fibrous mats of a fine-grained birefringent mineral. This mineral has been identified as hydronephelite by X-ray diffraction and has been interpreted by the author to be an alteration of former nepheline. Fresh nepheline was not observed. In general, hydronephelite is estimated to form between 5 and 10% of the rock.

The feldspar is an anhedral perthite consisting of both string and patch perthite. String perthite is dominant and rarely displays Carlsbad twinning. The patch

perthite consists of potassium feldspar replaced by albitic plagioclase. The composition of the plagioclase component is An 4–10.

Pegmatitic Syenite

Three specimens of very coarse–grained pegmatitic syenite were examined in thin section. The pegmatitic syenite appears to be restricted to diamond drill hole 8 of Algoma Ore Properties, located on the south subcomplex.

The very coarse–grained pegmatitic syenite is gradational into coarse–grained syenite implying that the pegmatitic samples represent late–stage, volatile–rich segregations in the syenite, and not late–stage intrusions.

In thin section, the rock is coarse grained, massive, inequigranular–seriate, hypidiomorphic with straight to curved grain boundaries. The mode is estimated to be 0 to 5% biotite, 0 to 3% opaques, 30 to 40% patch perthite (An 8–12) and 40 to 50% string perthite. The pegmatitic syenite is leucocratic relative to the other phases. Trace amounts of carbonate, quartz, and an unidentified brown alteration are present.

Biotite forms anhedral interstitial grains that are dark red–brown in colour. It displays a turbid alteration along some cleavage planes, and one specimen has bent (001) cleavage planes. One section contains carbonate and biotite between the feldspar crystals. The biotite occurs in contact with the feldspar, and the carbonate is segregated, implying that the carbonate was the last mineral to crystallize. The biotite separates the feldspar from the carbonate.

The opaque is probably magnetite. It is anhedral, intergranular, and locally has altered to red–brown limonite.

Feldspar consists of both string and patch perthites with string perthite dominant. The string perthite is often Carlsbad twinned, and the patch perthite appears to have formed by potassium feldspar replacement of an albitic plagioclase.

Biotite Granite

One specimen of a quartz–rich rock was collected from drill hole number 6 of Algoma Ore Properties. This may be a dike cutting the syenite phases of the complex, but its relationship to the syenite is unclear from the drill log or from the disaggregated core. The log indicates that 14.1 m of granite at the bottom of the hole lies beneath coarse–grained syenite. The granitic rock is red to light red–brown in colour. The rock's texture is fine to medium grained, equigranular, massive, hypidiomorphic with straight to curved grain boundaries. The mode is estimated to be 4 to 5% biotite, 30% quartz, and 65 to 70% perthite. Trace amounts of carbonate and sericite are present.

Biotite forms anhedral, interstitial, ragged, tabular grains with traces of associated carbonate.

Quartz is anhedral, interstitial, and in places displays a weak wavy extinction. Euhedral crystal faces of feldspar project into the quartz.

Perthite is anhedral to euhedral, slightly tabular in outline, and consists of both string and patch perthite. Carlsbad twinning is restricted to the string perthite and the patch perthite is the result of potassium feldspar replacement of an albitic plagioclase.

PALEOZOIC

Overlying the Nagagami River Alkalic Rock Complex are a series of Paleozoic rocks that are described in the drill logs of Algoma Ore Properties as limestone, siltstone, claystone, silty limestone, and sandstone. Limestone, apparently the

dominant lithology, is described in some logs as vuggy and fractured. The fractured and vuggy nature of the Paleozoic sedimentary rocks created problems in drilling and initial attempts at drilling inclined holes had to be abandoned in favour of vertical holes. Thin seams of gypsum were reported from several holes. Samples of the Paleozoic rocks were not available to the author for examination.

PETROLOGY

Chemical analyses were completed on a limited number of drill core samples (Appendix A, Tables A–2, A–3). Considering the size of the complex as inferred from the aeromagnetic anomaly, the samples probably do not represent all phases of the complex. Mild protoclastic textures in some samples suggest the complex was emplaced as a crystal mush and the presence of trace amounts of garnet and minor amounts of quartz in the melanocratic phases suggests possible contamination by assimilation of xenolithic wall rock fragments. The present chemical compositions, therefore, cannot be used to predict silicate melt compositions.

Norm calculations (Appendix A, Table A–4) and AFM plots (Figure 4) were calculated by the method of Irvine and Baragar (1971). Average compositions of the lithologic units were calculated by the method of Nie *et al.* (1975) and include most but not all the samples in each rock group.

AFM plots were prepared (Figure 4) to compare various rock groupings. The melanocratic amphibole–pyroxene syenite (Figure 4a) displays a reasonably tight cluster mid–way between the apices A and F. The plot fails to aid in determining whether the melanocratic rocks are altered xenolithic material or of magmatic derivation.

The medium–grained biotite–amphibole–pyroxene syenite displays a high degree of scatter on an AFM plot (Figure 4b). This scatter of data indicates this rock group does not likely represent a simple equivalent of magmatic liquid. This rock group displays considerable variation in mafic mineral content and it may, in part, be hybrid.

An AFM plot of the coarse–grained biotite–amphibole–pyroxene syenite samples indicates a broad clustering of data (Figure 4c). While the chemistry indicates a general similarity in composition between samples, the rocks were, however, likely emplaced as crystal mush and not as a liquid. The AFM plots, therefore, do not represent simple liquid equivalents.

Figure 4d illustrates an AFM plot of the trachytoidal coarse–grained syenite which is similar to that for the coarse–grained, biotite–amphibole–pyroxene syenite. This syenite is identical in grain size and mineralogy to the non–trachytoidal coarse–grained syenite. Euhedral to subhedral potassium feldspar crystals occur in an amphibole–rich matrix suggesting that the magma was emplaced as a mixture of potassium feldspar crystals and intercumulus mafic magma. The AFM plot of the chemistry cannot therefore be used to predict simple silicate melt compositions for this syenite phase.

The nepheline–bearing syenites plot in a tight cluster (Figure 4e) and they could indicate an approximation of an alkalic silicate melt, but the number of points is limited.

Figure 4f is a plot of the compositions of the pegmatitic and granitic phases. The points indicate highly evolved compositions but the number of points are too limited for interpretation.

METAMORPHISM

The rocks lack a granoblastic texture indicative of regional or post–emplacement metamorphism. The alteration of the mafic minerals to amphibole or biotite is

considered by the author to be the result of deuteric or autometamorphic processes during the final phase of igneous emplacement and not the result of a metamorphic event. On the basis of an observed lack of metamorphism and an aeromagnetic pattern indicating that the complex truncates a northwest–trending set of mafic dikes (diabase?), the author tentatively considers the complex to be Late Precambrian in age.

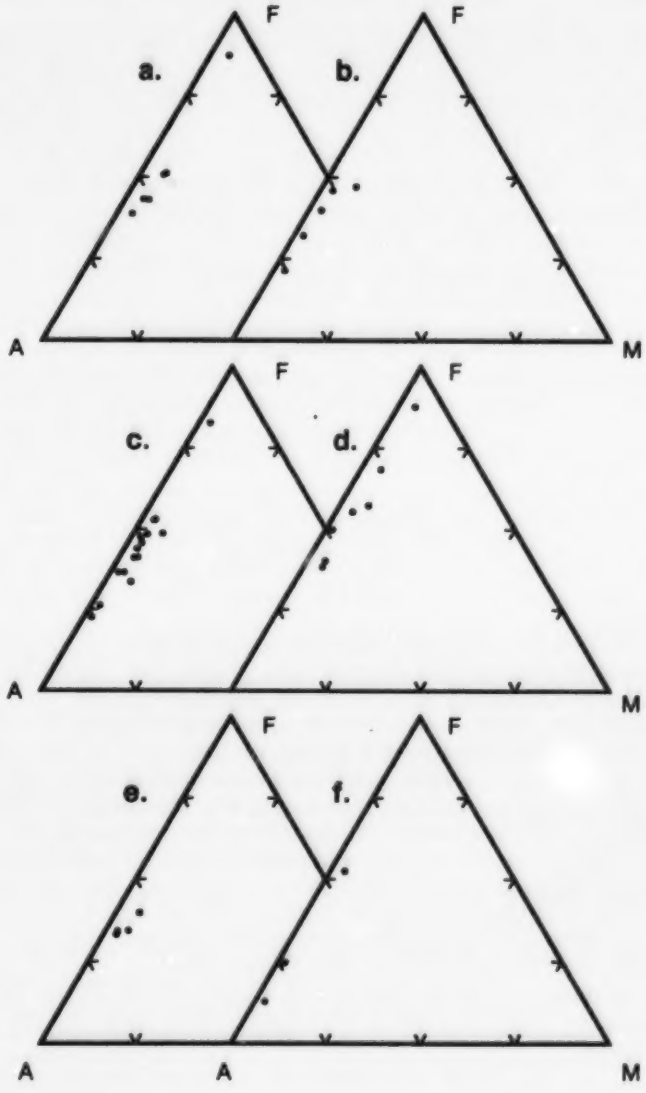

Figure 4. *AFM plots of samples from the Nagagami River Alkalic Rock Complex.* **a.** *melanocratic amphibole-pyroxene syenite.* **b.** *medium-grained biotite-amphibole-pyroxene syenite.* **c.** *coarse-grained biotite-amphibole-pyroxene syenite.* **d.** *coarse-grained trachytoidal amphibole-pyroxene syenite.* **e.** *nepheline-bearing biotite-amphibole syenite.* **f.** *pegmatitic syenite and granite.* $A = Na_2O + K_2O$; $F = FeO$ *(total)*; $M = MgO$.

STRUCTURAL GEOLOGY

In several core specimens, a trachytoidal texture is apparent. Such a preferred orientation of the feldspar is common in various syenitic phases of a number of alkalic rock complexes examined by the author. The preferred orientation of the feldspars likely was formed by alignment of the crystals parallel to the flow direction in the crystallizing syenite magma during emplacement.

A number of circular aeromagnetic anomalies within the region of the Nagagami Alkalic Rock Complex have been interpreted by Satterley (1970) as possibly due to buried alkalic rock–carbonatite complexes. These complexes have a crude west of north trend which may reflect structural control by basement rocks for their emplacement. The lack of an aeromagnetic pattern to infer such a structure, and the fact that the anomalies are buried beneath younger rocks prevents any assessment of what structure controlled emplacement.

Regional structures controlling its emplacement have not been clearly identified but the complex appears to lie along the extension of the northeast–striking Gravel River Fault. The Gravel River Fault forms a boundary to the Lake Superior basin near the Sibley Peninsula where it appears to exert some control on the position of the basin. Extrapolation of the trend of the Gravel River fault to the northeast would place the Nagagami River Alkalic Rock Complex and Martison Carbonatite Complex on the same linear.

GEOPHYSICS

An aeromagnetic survey by Algoma Ore Properties Division of Algoma Steel Corporation in 1961 outlined a horseshoe–shaped anomaly (*see* Figure 2). The company then contracted with Hunting Survey Corporation in 1963 to fly the area and interpret the results. The company flew the area at a line spacing of 1/4 mile (about 400 m) and outlined two circular structures. The north anomaly had a peak intensity of about 6500 or 5500 gammas and the south anomaly 3000 to 4200 gammas (Venn 1964?). Background is 3000 to 3500 gammas (Venn 1964?).

The aeromagnetic results were interpreted by Jagodits and Paterson (1964) to be due to magnetite–bearing ring complexes. The larger anomaly was initially interpreted to be due to a gabbro–syenite body, and the south complex to carbonatite. Jagodits and Paterson (1964) considered the smaller complex to be possibly younger and to intrude the larger.

The magnetic survey indicated that linear aeromagnetic anomalies with northwest and northeast trends cut the rocks enclosing the complex but not the complex itself. These trends have been interpreted as being due to diabase dikes (Jagodits and Paterson 1964). The fact that these geophysically inferred diabase dikes do not cut the Nagagami River Alkalic Rock Complex implies that the complex is younger than the diabase dikes. Jagodits and Paterson (1964) have also interpreted the presence of Early Precambrian sedimentary and volcanic rocks southwest of the Nagagami River Complex.

The federal–provincial aeromagnetic survey of the area (map 3913G, ODM–GSC 1967) also outlined a circular aeromagnetic anomaly.

RECOMMENDATIONS FOR FUTURE STUDY

A limited amount of microprobe work is needed and an isotopic age is highly desirable. A diligent effort should be made to save any core that may result from exploration of the complex. Future work is dependent on obtaining additional sample material.

Economic Geology

PROPERTY DESCRIPTIONS

ALGOMA ORE PROPERTIES [1964]

In 1961, Algoma Ore Properties Division of Algoma Steel Corporation flew an aeromagnetic survey over the area and identified a horseshoe–shaped anomaly. The presence of the anomaly was confirmed on the ground in the same year. In 1963, the company contracted Hunting Survey Corporation to carry out another aeromagnetic survey of the area at approximately 400 m line spacing and to interpret the results.

In 1964, the company obtained a license of occupation for the area covering the anomaly. The company completed two east–west baselines, one over the north anomaly and one over the south anomaly. The company then completed 3281 feet (984.3 m) of diamond drilling along the baseline over the north anomaly, and 1026 feet (307.8 m) over the south anomaly. The company initially attempted to drill inclined holes but encountered difficulties. Those holes that reached the target were drilled vertically. Core samples were checked with a scintillometer and a large number were checked for their niobium content. The assays ranged from 0.01 to 0.06% niobium pentoxide (Assessment Files Research Office, Ontario Geological Survey). The results were discouraging and the company terminated its work in the area.

RECOMMENDATIONS TO THE PROSPECTOR

The greatly reduced aeromagnetic anomaly over the rim of the Nagagami Alkalic Rock Complex relative to the intense aeromagnetic anomalies over the gabbro rims of both the Port Coldwell and Killala Lake Alkalic Rock Complexes, implies that the Nagagami River complex does not have a gabbro rim which might host copper, nickel and platinum group element mineralization as found at the Port Coldwell complex, and to a more limited extent, at the Killala Lake complex (ODM–GSC 1963, 1967). Niobium and/or uranium mineralization, by analogy with the Port Coldwell and Killila Lake complexes is likely to be present only in aplite dikes or pegmatitic phases of relatively small size. By the same analogy, this mineralization is not likely to exist in sufficient volume to be of economic interest.

The greatest economic potential of this complex may be the possible presence of an unaltered nepheline syenite phase within the south subcomplex which could be used for ceramics. Such a phase would likely be located towards the periphery of the complex and inward from the more mafic rim lying in contact with the wall rocks. The magnetite content of the syenite is not likely to approach a sufficient concentration to warrant consideration as a low grade iron deposit. Considering the size of the geophysically inferred surface area of the two subcomplexes, it must be realized that any estimate of the economic value of a complex, on the basis of such limited sampling of vertically drilled holes in a body likely to display vertical or steeply dipping internal structures, is extremely tenuous. The complex warrants additional work even though initial results are not encouraging.

The absence of thick overburden and/or Paleozoic cover over the south subcomplex of the body makes it more amenable to testing than the north.

A small circular magnetic anomaly of approximately 1.0 km diameter located approximately 6.0 km southwest of the Nagagami complex may warrant examination to determine if it is due to a carbonatite intrusion (Figure 2, and Sage 1979).

Appendix A — Petrographic Descriptions, Chemical Analyses, Normative Compositions, and Statistical Compositions of Lithologic Units of the Nagagami River Alkalic Rock Complex.

TABLE A-1. PETROGRAPHIC DESCRIPTIONS OF WHOLE-ROCK SAMPLES* FROM THE NAGAGAMI RIVER ALKALIC ROCK COMPLEX.

Reference No. 1486
Sample No. NAG 9-300-325A

Nepheline-bearing, biotite, amphibole syenite.

Coarse grained, massive, equigranular, hypidiomorphic, with curved grain boundaries. Amphibole is anhedral, interstitial, pleochroic in brown and green, and may enclose small feldspar grains. Biotite is anhedral to subhedral and forms tabular grains that form interlocking clusters. Magnetite is anhedral, rounded to subrounded and occurs in association with other mafic minerals and with patches of fine-grained fibrous alteration. The fine-grained alteration is probably a zeolite after former nepheline. The perthite forms anhedral irregular grains of patch and string types; string perthite is dominant.

Reference No. 1487
Sample No. NAG G (not analysed)

Amphibole, pyroxene syenite.

Coarse grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Clinopyroxene is anhedral and tends to cluster into aggregates of grains. It is colourless to very pale green. Amphibole is anhedral, interlocks with pyroxene and occurs commonly along margins of pyroxene grains. Amphibole is brown in colour. Biotite occurs in trace amounts in association with other mafic minerals. Magnetite occurs as anhedral rounded grains in association with other mafic minerals. It may in part be an alteration of pyroxene. Patch perthite is anhedral with minor pericline twinning. Plagiocase composition is An 8.

Reference No. 1488
Sample No. NAG E

Syenite pegmatite.

Coarse grained, equigranular, hypidiomorphic, with curved grain boundaries. Patch perthite consisting of anhedral to euhedral crystals of plagioclase (An 8-14) is undergoing potassium replacement. String perthite is anhedral and displays Carlsbad twinning. Patch and string perthite are approximately equal in volume. An interstitial mixture of carbonate and biotite occurs between feldspars. Biotite lies between the carbonate and feldspar and thus separates carbonate from the feldspars.

Reference No. 1489
Sample No. NAG 8-550-575

Syenite pegmatite.

Coarse grained, equigranular, massive, hypidiomorphic, with straight to curved grain boundaries. Plagioclase (An 10-12) forms a patch perthite with patchy potassium replacement. String perthite is Carlsbad twinned. Minor interstitial brown, greenish-brown alteration is present. Magnetite is anhedral and intergranular.

Reference No. 1490
Sample No. NAG 4-725-750

Pyroxene, biotite syenite.

Medium grained, equigranular, grading to inequigranular-seriate, allotriomorphic, with lobate to serrate grain boundaries. Reddish-brown biotite is fine grained, and also forms tabular grains

**All samples were taken from diamond drill core obtained by Algoma Ore Properties Division of Algoma Steel Corporation during their 1964 drill program. The locations of the drillholes are plotted on Figure 3. The sample number indicates the hole number and the interval in feet of the core sample (where known).*

in association with magnetite and clinopyroxene. Clinopyroxene is ragged, anhedral and undergoing extensive replacement by biotite; it may enclose the occasional magnetite grain. Magnetite is anhedral, closely associated with biotite, and may be enclosed in biotite. Magnetite is intergranular. Plagioclase (An 5-10) is anhedral, and undergoing patchy potassium replacement. String perthite is anhedral and interlocking. Perthite is commonly turbid and may enclose a rare grain of sericite mica.

Reference No. 1491
Sample No. NAG B

Nepheline-bearing, amphibole syenite.

Coarse grained, equigranular, allotriomorphic, with curved to lobate grain boundaries. Fine-grained fibrous alteration is possibly after nepheline. Biotite is minor and commonly forms narrow rims on magnetite grains. Magnetite is anhedral, rounded, interstitial and generally has a narrow rim of biotite. Amphibole forms brown to greenish-brown interstitial grains. Amphibole may enclose feldspar. Minor plagioclase is undergoing potassium replacement, and displays minor pericline twinning. Perthite is an anhedral interlocking string perthite.

Reference No. 1492
Sample No. NAG 4-575-600

Magnetite syenite.

Coarse grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Minor anhedral plagioclase displays pericline twinning and patchy potassium feldspar replacement. Clinopyroxene is anhedral and interstitial, with incipient alteration to amphibole. It may poikilitically enclose magnetite. Perthite is anhedral and stringy with some Carlsbad twinning. Magnetite is anhedral and intergranular with narrow rims of biotite and amphibole.

Reference No. 1493
Sample No. NAG 4-550-575

Pyroxene syenite.

Coarse grained, equigranular, massive, allotriomorphic, with straight to curved grain boundaries. Magnetite is anhedral and interstitial with narrow rims of pale green to brown amphibole and brown biotite. Biotite is minor, pale brown and rarely tabular in form. Clinopyroxene is anhedral, pale green in colour and shows incipient alteration to amphibole and biotite along its edges. Perthite is anhedral with a stringy texture and local Carlsbad twinning; it may poikilitically enclose magnetite. Minor pale green, slightly prismatic amphibole occurs as a breakdown product of pyroxene.

Reference No. 1494
Sample No. NAG 7-750-775

Melanocratic biotite, amphibole syenite.

Fine to medium grained, inequigranular-seriate, allotriomorphic, with curved grain boundaries. Minor pyroxene is altering to amphibole. Amphibole is anhedral, interstitial, and may enclose small feldspar and magnetite grains. Pleochroism is colourless to pale green. Biotite occurs as anhedral grains closely associated with amphibole; it may enclose magnetite and commonly occurs as interlocking tabular grains. Fracturing of some grains suggests a protoclastic texture. Pericline twinning is present. Perthite occurs as anhedral interlocking grains and is dominantly of the string type.

Reference No. 1495
Sample No. NAG 7-800-812

Amphibole, pyroxene syenite.

Medium grained, equigranular, massive, allotriomorphic, with curved to serrate grain boundaries. Zircon occurs as euhedral, concentrically zoned crystals. Trace amounts of garnet are present. Clinopyroxene is anhedral, colourless to pale green, and altering to amphibole. Amphibole is brown to greenish-brown, anhedral, closely associated with clinopyroxene and partially an alteration product of clinopyroxene. Minor biotite occurs as tabular grains, occasionally poikilitic in clinopyroxene. Plagioclase (An 6-8) is subhedral in form and is undergoing patchy replacement by potassium feldspar. Perthite is anhedral, dominantly of string type; locally patch perthite has developed in plagioclase. Feldspars display curved to serrate grain boundaries.

Reference No. 1496
Sample No. NAG 6-575-590

Biotite granite.

Fine to medium grained, equigranular, massive, hypidiomorphic, with straight to curved grain boundaries. Biotite is anhedral, interstitial and ragged, forming tabular grains with minor car-

bonate. Quartz is anhedral and interstitial; feldspar crystal faces may project into the quartz grains. Perthite forms anhedral to euhedral slightly tabular grains with both stringy and patch textures. Patch perthite is a replacement of albitic plagioclase displaying pericline twinning. Stringy perthite shows Carlsbad twinning.

Reference No. 1497
Sample No. NAG 4-625-650

Amphibole, pyroxene syenite.

Coarse grained, massive, equigranular, hypidiomorphic, with straight to serrate grain boundaries. Magnetite is anhedral, interstitial and some grains have narrow rims of amphibole. Amphibole is anhedral, brown to greenish-brown in colour, and generally occurs as patchy replacement of clinopyroxene. Plagioclase (An 4-6) is minor and appears broken and fractured; pericline twinning is present. Clinopyroxene is anhedral with ragged edges from alteration to amphibole; it may enclose occasional magnetite grains. Perthite is anhedral to subhedral, and tabular in form. Perthite is stringy and cryptoperthitic with minor Carlsbad twinning. Feldspars are crudely subparallel in orientation.

Reference No. 1498
Sample No. NAG 4-600-625

Biotite, amphibole syenite.

Medium grained, equigranular, massive, allotriomorphic, with straight to serrate grain boundaries. Minor clinopyroxene occurs as relicts; it is undergoing extensive alteration to biotite and amphibole. Amphibole is anhedral, brown to pale green in colour, commonly replacing pyroxene. Minor fine-grained anhedral biotite is replacing pyroxene; biotite rarely forms large tabular reddish-brown grains. Minor plagioclase shows pericline twinning. Perthite is dominantly stringy but locally is closer to patchy; Carlsbad twinning is present. Feldspar grain boundaries vary from straight to serrate. Magnetite is anhedral, interstitial, and commonly associated with amphibole-biotite alteration of pyroxene. It may partially enclose a feldspar grain. Narrow rims of amphibole and less commonly biotite were noted on some magnetite grains.

Reference No. 1499
Sample No. NAG 7-775-800B

Amphibole, pyroxene syenite.

Coarse grained, equigranular, massive, hypidiomorphic, with curved grain boundaries. Clinopyroxene is anhedral and forms interlocking aggregates of grains between feldspars. It is colourless to pale green and may contain small poikilitic inclusions of magnetite. Amphibole is anhedral and may enclose relict pyroxene; it is common as a patchy replacement of pyroxene. Magnetite forms anhedral, rounded, interstitial grains and may display a trace of amphibole along contacts with pyroxene grains. Perthite is anhedral to subhedral in form and dominantly a string perthite. Locally perthite is patchy.

Reference No. 1500
Sample No. NAG 7-775-800A

Amphibole, pyroxene syenite.

Coarse grained, massive, equigranular, hypidiomorphic, with curved grain boundaries. Clinopyroxene is colourless to pale green and anhedral; it shows patchy alteration to amphibole, rarely encloses feldspar and may enclose magnetite grains. Amphibole is anhedral and green to greenish-brown, commonly replacing pyroxene. Magnetite is anhedral and commonly associated with amphibole and biotite; traces of amphibole occur on margins of some magnetite grains. Biotite is anhedral, brown, and closely associated with magnetite. Perthite is anhedral and dominantly patchy. Potassium feldspar is somewhat turbid.

Reference No. 1501
Sample No. NAG 4-500-525

Biotite, pyroxene syenite.

Coarse grained, equigranular, massive, allotriomorphic, with curved to serrate grain boundaries. Clinopyroxene is anhedral, pale green in colour, commonly ragged from alteration to carbonate, biotite, amphibole. Biotite forms anhedral, ragged grains, generally after pyroxene and associated with carbonate. Magnetite is anhedral and rounded in form. Magnetite is commonly interstitial and may be poikilitic in pyroxene. Perthite is anhedral to subhedral with Carlsbad twinning of some grains and is dominantly stringy. Several grains are patch perthite. Potassium feldspar in patch perthite is often turbid. Traces of amphibole alteration are after pyroxene. Minor interstitial carbonate is present.

Reference No. 1502
Sample No. NAG 4-475-500A

Amphibole, pyroxene syenite.

Coarse grained, massive, equigranular, allotriomorphic, with straight to curved grain boundaries. Clinopyroxene is generally highly altered, altering to carbonate, biotite and amphibole. Carbonate is anhedral, interstitial and closely associated with biotite. Biotite is anhedral, and occurs as fine-grained alteration of pyroxene and as discrete tabular grains. Amphibole is ragged, greenish to greenish-brown, and an alteration of pyroxene. Magnetite is anhedral, interstitial, and may poikilitically enclose apatite. Narrow rims of fine-grained biotite are common along grain margins. String perthite forms anhedral tabular grains, commonly with Carlsbad twinning. Patch perthite is very minor.

Reference No. 1503
Sample No. NAG H

Amphibole, pyroxene syenite.

Coarse grained, equigranular, massive, hypidiomorphic, with curved grain boundaries. Magnetite is anhedral, rounded in form, interstitial and closely associated with pyroxene and amphibole. Amphibole is anhedral, brown, and occurs in association with pyroxene and as patchy alteration of pyroxene. Clinopyroxene is anhedral to subhedral, pale green, with occasional schiller texture, defined by two sets of oriented elongated opaque inclusions. It may poikilitically enclose magnetite and rarely apatite. Perthite occurs as anhedral, slightly tabular grains; local areas are not clearly perthitic except at high magnification. Traces of patch perthite are present. Some grains show Carlsbad twinning. Olivine is rare, anhedral, rounded in form, and displays brownish alteration along fractures.

Reference No. 1504
Sample No. NAG G

Amphibole, pyroxene syenite.

Coarse grained, massive, equigranular, hypidiomorphic, with curved grain boundaries. Olivine forms rounded grains with reddish-brown alteration along fractures. Clinopyroxene is anhedral to subhedral and pale green in colour. Some greenish-brown amphibole occurs along edges. Rare schiller texture is defined by two sets of inclusions at approximately 75° to each other. Brownish alteration occurs along fractures. Magnetite is anhedral, amoeboid and interstitial; it may enclose traces of apatite. Amphibole forms anhedral grains interstitial to clinopyroxene along edges of crystal. It may enclose relict pyroxene. Perthite is dominantly stringy, locally with quadrille twinning of microcline along edges of some larger grains. Occasional Carlsbad twinning is present.

Reference No. 1505
Sample No. NAG A

Amphibole, pyroxene syenite.

Coarse grained, equigranular, massive, hypidiomorphic, with curved grain boundaries. Magnetite forms anhedral interstitial grains which may enclose apatite and small pyroxene grains. Clinopyroxene is colourless to pale green, anhedral to subhedral, with minor greenish-brown amphibole along edges. Amphibole is greenish-brown, anhedral and common along margins of pyroxene grains. Perthite is anhedral to subhedral, generally stringy but patch perthite is also common. Minor Carlsbad twinning is present.

Reference No. 1506
Sample No. NAG F

Pyroxene, amphibole syenite.

Medium grained, equigranular, massive, allotriomorphic, with curved grain boundaries. Clinopyroxene forms rounded anhedral grains commonly mantled with thick rims of amphibole. Amphibole forms brown to greenish-brown interstitial grains, and may poikilitically enclose magnetite. Opaques are anhedral, interstitial, rounded, and associated with amphibole and pyroxene. Feldspar is untwinned; rarely, at high magnification, it is is seen to be perthitic. It may poikilitically enclose magnetite and clinopyroxene.

Reference No. 1507
Sample No. NAG 9-300-325B

Nepheline-bearing, biotite, amphibole syenite.

Coarse grained, equigranular, massive, allotriomorphic, with curved grain boundaries. Traces of interstitial carbonate are present. Magnetite is anhedral, disseminated and associated with

amphibole and biotite. Amphibole is anhedral, interstitial, brown to greenish-brown in colour. Biotite forms anhedral, interlocking tabular grains, often associated with amphibole. Perthite is anhedral, dominantly stringy, but patch perthite is also common. Patch perthite occurs in association with plagioclase (An4-6). Feldspar grains have curved grain boundaries. Patches of interstitial alteration consisting of carbonate and zeolite(?) are possibly after nepheline.

Reference No. 1508
Sample No. NAG 8-450-475

Pyroxene, amphibole syenite.

Coarse grained, equigranular, massive, allotriomorphic, with curved, lobate and serrate grain boundaries. Amphibole is anhedral, interstitial, green to brown, occasionally acicular, and rarely contains relict pyroxene. Biotite forms anhedral grains interlocking with amphibole; it may rim magnetite grains. Possible reddish-brown zircon has weak radioactive bombardment haloes. Clinopyroxene is anhedral, ragged and commonly thickly mantled with amphibole. Opaques are anhedral, closely associated with biotite and amphibole. Opaques may occur poikilitic in both. Feldspar is a string perthite with rare Carlsbad twinning. Grain boundaries are curved to lobate to serrate.

Reference No. 1509
Sample No. NAG 4-525-550

Pyroxene syenite.

Coarse grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. Clinopyroxene with relict shiller texture shows extensive alteration to fine-grained acicular amphibole, more rarely minor biotite. Carbonate is present as a minor interstitial phase. Biotite forms anhedral to subhedral grains, commonly associated with interstitial carbonate. Perthite is dominantly stringy, with minor patch perthite. Minor Carlsbad twinning is present and some grains appear fractured. Feldspar is flecked with sericite and carbonate alteration. Magnetite is anhedral, irregular in form, and closely associated with altering pyroxene.

Reference No. 1510
Sample No. NAG 4-750-775

Pyroxene syenite.

Medium grained, equigranular, massive, allotriomorphic, with lobate to cuspate grain boundaries. Clinopyroxene is anhedral, interstitial, colourless to pale green, with incipient alteration along margins to acicular green, amphibole and brown biotite. Magnetite is anhedral, interstitial and closely associated with clinopyroxene. Patch perthite contains irregular areas undergoing patchy replacement by potassium feldspar. Potassium feldspar is turbid. Plagioclase (An4-6) boundaries are lobate to cuspate.

Reference No. 1511
Sample No. NAG 7-725-750

Pyroxene syenite.

Coarse grained, massive, equigranular, allotriomorphic, with lobate to serrate grain boundaries. Minor anhedral interstitial opaques are present. Clinopyroxene is interstitial and undergoing reddish-brown alteration. It may enclose feldspar. Amphibole is present as small, acicular, green, prismatic grains in association with altering clinopyroxene. Two types of perthite are present: (1) patch perthite with potassium feldspar undergoing sericite, clay (?) and carbonate alteration, and (2) string perthite. Patch perthite is dominant. Carbonate alteration fills tiny fractures in feldspar.

Reference No. 1512
Sample No. NAG 6-525-550

Quartz-bearing, amphibole syenite.

Fine grained, equigranular, massive, allotriomorphic, with curved to lobate grain boundaries. Quartz is anhedral, interstitial, clear and unstressed. Amphibole is brown to greenish-brown, anhedral, and interlocking with feldspar. Clinopyroxene is ragged, colourless to pale green, mantled with amphibole. Pyroxene commonly displays a reddish-brown alteration. Microcline with well developed quadrille twinning is a minor component. Perthite is stringy with lobate to serrate grain boundaries. Mafic minerals are concentrated in gaps between feldspar crystals. Opaques occur as rounded anhedral grains, commonly poikilitic in amphibole.

Reference No. 1513
Sample No. NAG D

Pyroxene, amphibole syenite.

Coarse grained, massive, equigranular, allotriomorphic, with curved, lobate and embayed grain boundaries. Amphibole is anhedral, greenish-brown, interstitial and locally, thickly mantles

relict pyroxene cores. Pyroxene is anhedral, occurs as colourless to pale green cores to amphibole grains. Locally it appears fractured. Biotite is anhedral, ragged; it occurs in association with amphibole and as narrow rims on opaques. Magnetite is anhedral, rounded in form, and commonly enclosed in amphibole. Perthite is a string perthite, anhedral with lobate to serrate grain boundaries, and a suggestion of fracturing. One angular inclusion of plagioclase is enclosed. Some Carlsbad twinning is present.

Reference No. 1514
Sample No. NAG C

Biotite syenite.

Coarse grained, massive, equigranular, allotriomorphic, with curved, lobate, and serrate grain boundaries. Minor green to brown amphibole occurs in association with biotite. Anhedral ragged grains of biotite are interstitial and interlocking in gaps between feldspar grains. Plagioclase (An4) is minor and occurs as angular anhedral to subhedral grains. Perthite is stringy, with rare angular inclusions of plagioclase. Perthite grains display serrate to lobate grain boundaries.

Reference No. 1515
Sample No. NAG 4-475-500B

Amphibole, pyroxene syenite.

Coarse grained, massive, equigranular, hypidiomorphic, with curved grain boundaries. Clinopyroxene is anhedral to subhedral, colourless to pale green, and shows extensive spotty alteration to fine-grained biotite, possibly minor amphibole. Biotite is yellow-brown in colour, anhedral, and is common along pyroxene grain boundaries and along fractures in pyroxene. Larger grains may be zoned from pale yellow-brown cores to dark reddish-brown rims. Magnetite is anhedral, interstitial, and may enclose the occasional apatite grain. Plagioclase is very minor, anhedral, interstitial (?), but appears more euhedral than perthite. In one case it appears to be crystal fragment enclosed in perthite. Perthite is stringy and displays patchy alteration to sericite and carbonate. The mineral is anhedral to interstitial and displays some Carlsbad twinning.

Reference No. 1516
Sample No. NAG 4-775-800B

Pyroxene syenite.

Medium grained, equigranular, massive, allotriomorphic, protoclastic, with lobate to embayed grain boundaries. Pyroxene occurs as anhedral grains with incipient biotite and amphibole alteration along margins. Magnetite is anhedral, interstitial and may occur as poikilitic grains in clinopyroxene. Perthite is an anhedral microperthite, interstitial and untwinned. Feldspar is dominantly plagioclase (An8-10) with embayed to lobate grain boundaries. Feldspar grains appear to be fractured and possibly protoclastic.

Reference No. 1517
Sample No. NAG 4-775-800A

Melanocratic pyroxene syenite.

Medium grained, equigranular, massive, hypidiomorphic, with curved grain boundaries. Potassium feldspar is anhedral, interstitial and appears to be a microperthite under high magnification. Carlsbad twinning is seen in some grains. Feldspar appears fractured. Magnetite is anhedral, interstitial and may poikilitically enclose apatite, feldspar, and rarely pyroxene. Pyroxene is anhedral to subhedral and rarely may display some schiller texture. Grains are highly fractured; fractures commonly look like kink bands. Pyroxene poikilitically encloses opaques and rare biotite. Microcline is present as anhedral, interstitial grains with good quadrille twinning. Apatite is subhedral, forming elongate crystals and may be poikilitic in magnetite. Amphibole occurs as brown, anhedral, interstitial grains and as patchy replacement of pyroxene grains. Incipient amphibole development is seen along pyroxene grain boundaries.

Reference No. 1549
Sample No. N4-84-575B

Biotite, magnetite, pyroxene syenite.

Medium to coarse grained, inequigranular, seriate, allotriomorphic, with curved to lobate grain boundaries. Biotite forms brown, anhedral, interstitial grains. Antiperthite forms elongate, anhedral grains with extensive potassium feldspar replacement. Replacement may display crude cleavage control. Perthite is a microperthite with rare Carlsbad twinning. Perthite is anhedral in outline and clouded. Minor elongated prismatic apatite is present. Clinopyroxene is green, anhedral and interlocking with feldspars; rarely it encloses subrounded grains of magnetite. Mag-

netite is anhedral, disseminated, and commonly has traces of biotite along margins; rarely it occurs as subrounded grains in clinopyroxene. Larger magnetite grains may enclose rounded grains of carbonate and biotite.

Reference No. 1550
Sample No. N4-64-575A

Amphibole, magnetite, pyroxene syenite.

Fine to medium grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Magnetite is anhedral, disseminated, commonly with traces of biotite along edges. Rarely it is poikilitic in clinopyroxene. Perthite is a cryptoperthite (?) which is turbid, anhedral, and has rare Carlsbad twinning. Antiperthite (An5-8) forms ragged, somewhat elongate, anhedral grains, with extensive patchy potassium replacement. There may be some crude cleavage control on the replacement. Biotite occurs in very minor amounts, and is dark brown, anhedral, interstitial. Amphibole is brown to dark yellowish-brown. Anhedral amphibole may replace pyroxene. Clinopyroxene is anhedral, irregular in outline, with pale green to colourless pleochroism. Incipient alteration to amphibole occurs along edges of cracks.

Reference No. 1551
Sample No. N5-64

Magnetite, pyroxene, amphibole syenite.

Fine grained, massive, equigranular, allotriomorphic, with straight to curved grain boundaries. Perthite occurs as rounded elongated grains with crudely subparallel orientation, imparting a trachytoidal texture to the rock. Perthite is fresh and unclouded. Magnetite occurs as anhedral, subrounded grains and is disseminated throughout. Amphibole is anhedral, displays brown to greenish-brown pleochroism; it may replace pyroxene or enclose or interlock with round grains of greenish-brown pyroxene. Clinopyroxene forms pale green, rounded to subrounded grains interlocking with amphibole and is in part being replaced by amphibole. It may enclose the occasional rounded magnetite grain.

Reference No. 1552
Sample No. H8-442

Biotite syenite.

Medium to coarse grained, massive, inequigranular-seriate, allotriomorphic, with curved to lobate grain boundaries. Perthite is anhedral and dominantly stringy; some is patch perthite. Carlsbad twinning is present. Alteration forms a fine-grained mat, interstitial, possibly zeolitic, possibly after nepheline. Brown to reddish-brown grains of biotite form interlocking interstitial aggregates. Patch perthite is likely a replacement of plagioclase by potassium feldspar. Traces of interstitial fluorite are present.

Reference No. 1553
Sample No. H8-500

Olivine-bearing, amphibole, pyroxene syenite.

Medium to coarse grained, inequigranular-seriate, allotriomorphic, with curved to straight grain boundaries. Olivine forms rounded grains altering to talc and iddingsite, and is closely associated with amphibole and pyroxene. Amphibole is anhedral, dark greenish-brown, interstitial, and may mantle and enclose pyroxene. Amphibole appears largely primary and has sharp contacts with pyroxene grains. Clinopyroxene is anhedral, green, possibly an aegirine augite; it commonly is enclosed or partially enclosed by amphibole. Traces of apatite are poikilitic in amphibole. Traces of interstitial fluorite are present. Perthite is anhedral, Carlsbad twinned, and has a stringy texture. The feldspar forms tabular grains interlocking with each other. Several small grains of feldspar are enclosed within the interstitial amphibole.

Reference No. 1554
Sample No. H8-520

Olivine-bearing, amphibole syenite.

Medium to coarse grained, massive, inequigranular-seriate, allotriomorphic, with curved to straight grain boundaries. Minor subhedral clinozoisite is present. Biotite occurs as reddish-brown, ragged grains replacing amphibole, and as interlocking aggregates of several crystals. Grains are roughly tabular in outline and all are interstitial. Amphibole forms dark green to greenish-brown interstitial grains. It may enclose traces of pyroxene, and biotite possibly replaces it. Olivine occurs in trace amounts, and is replaced by iddingsite, magnetite (?), and chlorite. There are traces of anhedral magnetite, carbonate as alteration of mafics, and green clinopyroxene. Perthite (An10) is anhedral and dominantly stringy. Patch perthite is likely a potassium feldspar replacement of plagioclase. String perthite displays Carlsbad twinning.

Reference No. 1555
Sample No. H9-335

Biotite, nepheline syenite.

Medium to coarse grained, massive, inequigranular-seriate, allotriomorphic to hypidiomorphic, with straight to curved grain boundaries. Biotite occurs as anhedral, dark brown, interstitial grains with possibly traces of chlorite alteration. Perthite (An7-10) is dominantly patchy with minor stringy texture. Albite occurs in gaps between perthite crystals. Feldspars are anhedral to subhedral. Scattered grains of clinozoisite and traces of carbonate are present. Minor fluorite occurs interstitially and as irregular blebs within feldspars. Fine-grained, dull brick red, interstitial zeolitic (?) alteration after nepheline comprises a visually estimated 15% of the rock.

Reference No. 1556
Sample No. H9-390

Biotite, amphibole syenite.

Medium to coarse grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Dark greenish-brown amphibole is anhedral, interstitial with incipient alteration to chlorite and biotite. Biotite is anhedral, associated with amphibole and dark greenish-brown in colour. Perthite is anhedral, dominantly a patch perthite with some stringy perthite. Albite twinning is common (An7). Traces of poikilitic apatite occur in mafics. Traces of carbonate and opaques are alteration products. Possibly fine-grained zeolite and/or sericite after nepheline is interstitial to some perthite grains. Nepheline, if formerly present, constitutes less than 5% of rock.

TABLE A-2. MAJOR ELEMENT ANALYSES (WEIGHT PERCENT) OF WHOLE-ROCK SAMPLES FROM THE NAGAGAMI RIVER ALKALIC ROCK COMPLEX.

	Coarse-grained Syenite						
Ref. No.	1508	1511	1502	1515	1501	1509	1493
SiO_2	58.90	60.10	35.40	53.50	54.00	55.50	52.70
Al_2O_3	17.70	20.40	12.40	15.40	17.60	17.10	16.90
Fe_2O_3	3.05	1.14	20.70	6.67	5.57	4.83	6.83
FeO	4.08	2.41	13.60	6.24	5.16	4.74	5.82
MgO	0.30	0.43	1.27	0.97	0.89	0.83	0.87
CaO	2.02	1.56	3.10	3.01	2.97	2.91	2.97
Na_2O	6.70	6.35	2.94	5.13	5.45	5.48	5.56
K_2O	5.20	5.67	3.12	5.20	5.01	5.20	4.70
TiO_2	0.47	0.42	3.77	1.75	1.25	1.04	1.30
P_2O_5	0.05	0.06	0.14	0.32	0.25	0.24	0.22
S	0.02	0.03	0.30	0.12	0.12	0.09	0.12
MnO	0.18	0.08	0.48	0.20	0.17	0.16	0.23
CO_2	0.40	0.70	0.92	1.12	0.83	1.67	0.97
H_2O+	0.28	0.19	0.03	0.12	0.16	0.05	0.04
H_2O-	0.08	0.18	0.48	0.32	0.40	0.40	0.40
Total	99.40	99.70	98.60	100.10	99.80	100.20	99.60
S.G.	2.71	2.63	3.33	2.82	2.79	2.74	2.82

	Coarse-grained Syenite					
Ref. No.	1492	1514	1513	1549	1552	1554
SiO_2	56.10	57.10	57.50	56.1	56.4	56.0
Al_2O_3	17.80	19.50	18.10	17.6	20.6	24.8
Fe_2O_3	4.66	1.65	2.50	6.01	6.58	1.92
FeO	4.08	4.24	4.66	4.76	0.0	2.23
MgO	0.73	0.75	0.64	0.56	1.16	0.47
CaO	2.83	2.01	2.34	2.09	1.16	1.64
Na_2O	5.54	5.79	5.74	5.94	4.11	6.29
K_2O	5.00	6.19	5.94	5.26	6.78	5.22
TiO_2	1.63	0.52	0.51	1.11	0.17	0.12
P_2O_5	0.15	0.09	0.10	0.17	0.02	0.03
S	0.15	0.02	0.05	0.09	0.08	0.02
MnO	0.16	0.15	0.20	0.19	0.12	0.12
CO_2	0.73	0.69	0.44	0.61	0.26	0.50
H_2O+	0.0	0.71	0.53	0.28	0.0	1.03
H_2O-	0.38	0.35	0.24	0.41	1.01	0.52
Total	99.90	99.80	99.40	101.10	100.00	100.90
S.G.	2.73	2.69	2.73	2.75	2.58	2.66

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1508	NAG8 450-475	1492	NAG4 575-600
1511	NAG7 725-750	1514	NAG C
1502	NAG4 475-500A	1513	NAG D
1515	NAG4 475-500B	1549	N4 64-575B
1501	NAG4 500-525	1552	H8 442
1509	NAG4 525-550	1554	H8 520
1493	NAG4 550-575		

TABLE A-2. CONTINUED.

	Medium-grained Syenite					Nepheline-bearing Syenite	
Ref. No.	**1498**	**1490**	**1510**	**1550**	**1516**	**1486**	**1507**
SiO_2	56.80	57.20	57.00	55.4	57.70	56.10	57.70
Al_2O_3	18.70	17.90	17.50	20.6	17.40	17.20	18.40
Fe_2O_3	4.01	3.17	4.51	4.44	3.73	3.53	2.59
FeO	4.58	4.08	3.74	3.84	4.08	4.33	3.66
MgO	0.55	0.71	0.85	0.40	0.81	1.25	0.63
CaO	2.21	2.40	2.46	2.47	2.52	2.89	2.36
Na_2O	6.37	6.19	6.00	5.79	5.98	4.58	5.09
K_2O	5.08	5.11	5.10	4.98	5.02	6.36	6.61
TiO_2	0.84	0.97	0.97	0.90	0.96	0.66	0.49
P_2O_5	0.16	0.12	0.18	0.19	0.18	0.13	0.10
S	0.01	0.01	0.01	0.01	0.01	0.01	0.04
MnO	0.14	0.12	0.14	0.14	0.14	0.19	0.16
CO_2	1.26	0.44	0.63	0.55	0.60	1.36	0.98
H_2O+	0.0	0.22	0.18	0.11	0.19	0.80	0.74
H_2O-	0.42	0.34	0.36	0.58	0.42	0.23	0.43
Total	101.00	99.00	99.60	100.90	99.70	99.60	100.00
S.G.	2.73	2.70	2.72	2.72	2.71	2.69	2.67

	Nepheline-bearing Syenite			Miscellaneous		
Ref. No.	**1555**	**1491**	**1556**	**1489**	**1496**	**1488**
SiO_2	55.1	58.10	56.4	59.20	67.60	61.30
Al_2O_3	18.8	18.60	18.6	18.30	18.30	20.50
Fe_2O_3	3.23	2.45	2.96	3.78	0.06	2.46
FeO	4.84	4.08	3.99	2.75	1.16	1.66
MgO	0.86	0.66	1.08	0.22	0.24	0.21
CaO	2.51	2.18	2.56	1.48	1.61	1.22
Na_2O	5.48	5.48	5.75	6.70	3.72	6.93
K_2O	5.51	6.39	6.26	5.68	5.11	5.76
TiO_2	0.45	0.45	0.58	0.28	0.11	0.18
P_2O_5	0.06	0.09	0.13	0.0	0.0	0.0
S	0.02	0.04	<0.01	0.02	0.03	0.01
MnO	0.15	0.16	0.19	0.06	0.03	0.05
CO_2	1.56	0.50	1.02	0.16	0.96	0.23
H_2O+	0.65	0.52	0.42	0.38	0.0	0.32
H_2O-	0.56	0.26	0.49	0.12	0.49	0.21
Total	99.8	100.00	100.4	99.10	99.40	101.00
S.G.	2.65	2.70	2.68	2.52	2.58	2.62

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1498	NAG4 600-625	1555	H9 335
1490	NAG4 725-750	1491	NAG B
1510	NAG4 750-775	1556	H9 390
1550	N4 64-575A	1489	NAG8 550-575
1516	NAG4 775-800B	1496	NAG6 575-590
1486	NAG9 300-325A	1488	NAG E
1507	NAG9 300-325B		

TABLE A-2. CONTINUED.

	Trachytoid Coarse-grained Syenite						
Ref. No.	1499	1500	1505	1504	1503	1553	1497
SiO_2	61.90	56.20	53.10	53.70	47.70	54.0	56.50
Al_2O_3	17.30	15.70	15.90	12.50	12.80	18.1	17.50
Fe_2O_3	1.51	2.58	5.41	2.70	8.00	4.05	4.07
FeO	4.24	7.40	7.82	10.40	11.80	7.07	4.33
MgO	0.44	1.35	1.01	1.68	1.43	0.34	0.85
CaO	2.00	6.08	4.52	7.92	6.21	3.04	2.54
Na_2O	5.67	4.94	4.97	4.29	4.21	5.67	5.68
K_2O	5.64	4.28	4.23	3.63	3.35	5.04	5.26
TiO_2	0.50	0.74	2.03	1.06	2.45	0.84	1.17
P_2O_5	0.05	0.13	0.15	0.19	0.55	0.03	0.16
S	0.01	0.06	0.07	0.12	0.21	0.03	0.01
MnO	0.15	0.26	0.28	0.35	0.46	0.29	0.14
CO_2	0.20	0.55	0.59	0.45	0.53	0.29	0.67
H_2O+	0.47	0.21	0.08	0.03	0.04	0.05	0.0
H_2O-	0.06	0.20	0.22	0.26	0.30	0.40	0.45
Total	100.10	100.70	100.30	99.30	100.00	99.2	99.33
S.G.	2.77	2.83	2.88	2.95	3.08	2.81	2.73

	Melanocratic Syenite					
Ref. No.	1494	1495	1512	1506	1517	1551
SiO_2	53.90	56.20	56.70	53.60	28.60	51.8
Al_2O_3	17.60	16.50	16.60	15.40	6.63	18.3
Fe_2O_3	1.88	1.85	2.65	3.25	19.90	3.27
FeO	7.40	6.82	6.16	8.24	20.00	8.22
MgO	1.74	1.22	0.98	1.39	2.05	1.48
CaO	5.21	3.84	4.31	4.51	8.96	4.58
Na_2O	5.38	5.67	5.35	5.26	2.14	5.19
K_2O	3.06	4.10	4.68	4.30	1.19	4.09
TiO_2	1.58	1.02	0.97	1.43	6.78	1.43
P_2O_5	0.77	0.48	0.14	0.40	1.87	0.39
S	0.07	0.04	0.09	0.12	0.07	0.11
MnO	0.17	0.20	0.19	0.25	0.69	0.27
CO_2	0.20	0.51	0.58	0.45	0.79	0.30
H_2O+	0.06	0.21	0.28	0.09	0.14	0.17
H_2O-	0.28	0.45	0.24	0.38	0.53	0.33
Total	99.30	99.10	99.90	99.10	100.30	99.9
S.G.	2.82	2.79	2.69	2.87	3.65	2.88

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1499	NAG7 775-800B	1494	NAG7 750-775
1500	NAG7 775-800A	1495	NAG7 800-812
1505	NAG A	1512	NAG5 525-550
1504	NAG G	1506	NAG F
1503	NAG H	1517	NAG4 775-800A
1553	H8-500	1551	N5-64
1497	NAG4 625-650		

TABLE A-3. TRACE ELEMENT ANALYSES (PPM) OF WHOLE-ROCK SAMPLES FROM THE NAGAGAMI RIVER ALKALIC ROCK COMPLEX.

	Coarse-grained Syenite						
Ref. No.	1508	1511	1502	1515	1501	1509	1493
Ag	1	1	1	1	1	1	1
Au							
As							
Ba	180	1300	330	650	650	680	560
Be	3	2	6	3	2	2	2
Bi							
Co	<5	<5	6	<5	<5	<5	<5
Cr	<5	<5	7	7	5	6	6
Cu	6	10	32	18	15	12	17
Ga	51	45	68	38	42	34	41
Hg							
Li	12	16	31	20	20	22	16
Mn							
Mo	<1	<1	7	3	<1	2	<1
Nb	400	<30	500	150	100	100	150
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	14	14	17	22	18	21	19
Rb	210	140	90	90	100	100	110
Sb							
Sc	<5	<5	25	20	20	15	25
Sn	5	1	29	3	2	1	3
Sr	70	250	<60	150	150	150	100
Ti							
V	<10	<10	<10	<10	<10	<10	<10
Y	100	25	60	50	60	50	60
Zn	200	62	330	160	122	380	108
Zr	700	100	600	200	250	200	250
La	900	<100	<100	<100	<100	<100	100
Nd	360	50	90	80	80	80	100
Ce	960	110	180	160	160	160	220
Yb	9	<1	9	3	4	2	3

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1508	NAG8 450-475	1501	NAG4 500-525
1511	NAG7 725-750	1509	NAG4 525-550
1502	NAG4 475-500A	1493	NAG4 550-575
1515	NAG4 475-500B		

TABLE A-3. CONTINUED.

	Coarse-grained Syenite					
Ref. No.	1492	1514	1513	1549	1552	1554
Ag	1	1	1	<2	-	<2
Au						
As						
Ba	640	1140	1200	580	-	110
Be	1	3	2	3	-	3
Bi						
Co	<5	<5	<5	<5	-	<5
Cr	<5	<5	<5	<5	-	<5
Cu	20	10	13	14	-	8
Ga	45	44	55	25	37	29
Hg						
Li	17	59	24	12	-	8
Mn						
Mo	<1	3	<1	<10	-	<10
Nb	70	400	200	200	400	200
Ni	<5	<5	<5	<5	-	<5
Pb	15	14	21	13	-	<10
Rb	100	330	170	150	340	200
Sb						
Sc	15	6	8	10	<5	<5
Sn	1	5	2	5	9	2
Sr	150	250	300	110	-	195
Ti						
V	<10	<10	<10	-	-	-
Y	35	70	60	40	40	60
Zn	76	160	140	131	-	96
Zr	150	700	450	-	-	-
La	<100	200	150	100	<100	500
Nd	50	140	120	<300	<300	<300
Ce	100	380	300	160	170	930
Yb	1	6	4	4	4	8
Eu				<100	<100	<100

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1492	NAG4 575-600	1549	N4 64-575B
1514	NAG C	1552	H8 442
1513	NAG D	1554	H8 520

TABLE A-3. CONTINUED.

	Medium-grained Syenite					Nepheline-bearing Syenite	
Ref. No.	**1498**	**1490**	**1510**	**1550**	**1516**	**1486**	**1507**
Ag	<1	<1	<1	<2	<1	1	1
Au							
As							
Ba	490	340	350	340	350	1500	1560
Be	2	1	2	1	1	3	3
Bi							
Co	<5	<5	<5	5	<5	<5	<5
Cr	<5	<5	8	<5	<5	<5	<5
Cu	<5	<5	<5	6	<5	12	10
Ga	23	27	30	20	27	35	37
Hg							
Li	22	32	16	11	18	36	30
Mn							
Mo	<1	<1	<1	<10	<1	<1	<1
Nb	90	<30	80	50	40	350	350
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	14	17	17	<10	15	17	16
Rb	90	120	110	100	100	170	160
Sb							
Sc	25	15	20	20	20	15	7
Sn	1	1	1	2	1	3	2
Sr	100	<60	<60	80	<60	250	250
Ti							
V	<10	<10	<10	-	<10	<10	<10
Y	30	<10	45	20	25	80	70
Zn	140	108	129	100	100	150	114
Zr	100	80	150	-	80	700	500
La	<100	<100	<100	<100	<100	250	200
Nd	50	40	50	<300	40	150	130
Ce	90	90	120	50	80	370	330
Yb	1	1	1	2	1	7	5

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1498	NAG4 600-625	1516	NAG4 775-800B
1490	NAG4 725-750	1486	NAG9 300-325A
1510	NAG4 750-775	1507	NAG9 300-325B
1550	N4 64-575A		

TABLE A-3. CONTINUED.

	Nepheline-bearing Syenite			Miscellaneous		
Ref. No.	1555	1491	1556	1489	1496	1488
Ag	<2	1	<2	<1	<1	<1
Au						
As						
Ba	530	1340	1530	90	190	100
Be	4	2	5	2	10	1
Bi						
Co	<5	<5	<5	<5	<5	<5
Cr	<5	<5	<5	<5	<5	5
Cu	6	12	6	<5	<5	<5
Ga	33	39	22	44	56	49
Hg						
Li	38	24	26	11	47	12
Mn						
Mo	<10	<1	13	<1	<1	<1
Nb	600	400	500	200	350	150
Ni	<5	<5	<5	<5	<5	<5
Pb	<10	20	12	<10	18	10
Rb	230	150	200	320	380	340
Sb						
Sc	7	6	9	<5	<5	<5
Sn	50	3	4	2	8	1
Sr	80	250	195	<60	<60	<60
Ti						
V	-	<10	-	<10	<10	<10
Y	80	70	60	40	80	40
Zn	170	129	150	48	43	44
Zr	-	600	-	150	250	20
La	150	200	400	<100	150	<100
Nd	<300	150	<300	60	70	60
Ce	270	370	570	190	230	200
Yb	11	5	11	<1	10	<1

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1555	H9 335	1489	NAG8 550-575
1491	NAG B	1496	NAG6 575-590
1556	H9 390	1488	NAG E

TABLE A-3. CONTINUED.

	Trachytoid Coarse-grained Syenite						
Ref. No.	**1499**	**1500**	**1505**	**1504**	**1503**	**1553**	**1497**
Ag	<1	<1	<1	<1	<1	<2	<1
Au							
As							
Ba	600	800	1000	610	830	120	320
Be	4	2	2	2	1	4	1
Bi							
Co	<5	<5	<5	6	7	<5	<5
Cr	6	<5	<5	<5	10	<5	5
Cu	<5	12	12	24	26	10	<5
Ga	39	32	37	33	36	28	30
Hg							
Li	18	21	12	22	10	6	12
Mn							
Mo	10	<1	3	<1	7	<10	<1
Nb	200	100	90	150	250	600	<30
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	14	16	14	17	10	<10	<10
Rb	160	100	80	80	60	210	90
Sb							
Sc	10	40	25	60	30	<5	20
Sn	4	3	3	3	2	3	1
Sr	<60	200	250	200	250	15	<60
Ti							
V	<10	<10	<10	<10	<10	-	<10
Y	70	60	45	60	60	60	<10
Zn	143	150	220	190	300	210	79
Zr	600	250	250	450	300	-	80
La	200	<100	<100	100	<100	400	<100
Nd	140	80	80	120	130	<300	<100
Ce	360	160	150	220	250	670	70
Yb	6	5	3	7	6	11	<1

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1499	NAG7 775-800B	1503	NAG H
1500	NAG7 775-800A	1553	H8-500
1505	NAG A	1497	NAG4 625-650
1504	NAG G		

TABLE A-3. CONTINUED.

	Melanocratic Syenite					
Ref. No.	1494	1495	1512	1506	1517	1551
Ag	<1	<1	<1	<1	<1	<2
Au						
As						
Ba	2300	1300	850	2340	130	2110
Be	2	12	2	1	2	1
Bi						
Co	10	5	5	6	11	7
Cr	6	<5	<5	6	5	<5
Cu	16	12	22	15	11	12
Ga	33	50	34	39	40	21
Hg						
Li	34	38	20	15	12	10
Mn						
Mo	<1	<1	1	<1	20	<10
Nb	90	300	150	450	400	500
Ni	<5	<5	<5	<5	<5	<5
Pb	15	39	21	10	<10	<10
Rb	50	140	120	60	20	70
Sb						
Sc	30	20	30	20	70	20
Sn	2	8	3	2	8	<1
Sr	700	450	200	500	<60	440
Ti						
V	20	<10	100	<10	<10	-
Y	45	350	600	80	90	60
Zn	128	220	150	180	560	200
Zr	150	4000	2505	300	450	-
La	<100	800	<100	250	200	300
Nd	100	360	70	230	250	<300
Ce	180	910	170	480	470	700
Yb	2	30	4	6	10	6

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1494	NAG7 750-775	1506	NAG F
1495	NAG7 800-812	1517	NAG4 775-800A
1512	NAG5 525-550	1551	N5-64

TABLE A-4. NORMATIVE MINERALS (CIPW NORM) FOR WHOLE-ROCK SAMPLES FROM THE NAGAGAMI RIVER ALKALIC ROCK COMPLEX.

	Coarse-grained Syenite						
Ref. No.	**1508**	**1511**	**1502**	**1515**	**1501**	**1509**	**1493**
AP	0.1	0.1	0.3	0.8	0.6	0.6	0.5
PO	0.1	0.1	0.9	0.3	0.3	0.3	0.3
IL	0.9	0.8	7.5	3.4	2.4	2.0	2.5
OR	31.2	34.0	19.3	31.3	30.2	31.4	28.4
AB	45.9	48.6	4.3	35.1	36.1	39.0	34.1
AN	2.9	7.4	12.0	3.7	8.9	6.9	7.4
C	0.0	1.1	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	2.9	1.7	8.0	4.8	4.1	3.8	4.2
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	0.7	0.0	0.2	1.6	0.8	1.2	0.9
FO	0.3	0.8	2.2	1.2	1.3	1.1	1.3
FA	3.4	2.2	30.9	6.3	6.3	5.0	8.3
NE	6.3	3.2	11.8	5.0	5.9	4.5	7.6
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	5.4	0.0	2.6	6.5	3.0	4.3	4.5
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

AP - Apatite; PO - Pyrrhotite; IL - Ilmenite; OR - Orthoclase; AB - Albite; AN - Anorthite; C - Corundum; AC - Acmite; MT - Magnetite; HM - Hematite; WO - Wollastonite; EN - Enstatite; FS - Ferrosilite; Q - Quartz; DI - Diopside; FO - Forsterite; FA - Fayalite; NE - Nepheline; LC - Leucite; KP - Kaliophilite; HE - Hedenbergite; CC - Calcite; RU - Rutile; NS - Na_2SiO_3; KS - Kalsilite; CR - Chromite; LN - Larnite

Note: For sample descriptions, see Table A-1.

Ref. No.	Sample No.	Ref. No.	Sample No.
1508	NAG8 450-475	1501	NAG4 500-525
1511	NAG7 725-750	1509	NAG4 525-550
1502	NAG4 475-500A	1493	NAG4 550-575
1515	NAG4 475-500B		

TABLE A-4. CONTINUED.

	Coarse-grained Syenite					
Ref. No.	1492	1514	1513	1549	1552	1554
AP	0.4	0.2	0.2	0.395	0.048	0.070
PO	0.4	0.1	0.1	0.247	0.226	0.055
IL	3.1	1.0	1.0	2.112	-0.126	0.231
OR	30.0	37.3	35.7	31.164	41.284	31.235
AB	43.1	36.3	38.6	43.600	35.797	42.973
AN	9.1	9.1	6.2	5.823	5.790	8.032
C	0.0	0.0	0.0	0.0	4.563	5.957
AC	0.0	0.0	0.0	0.0	0.0	0.0
MT	4.6	2.4	3.0	8.728	0.0	2.816
HM	0.0	0.0	0.0	0.0	6.774	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0
EN	0.0	0.0	0.0	0.0	2.974	0.0
FS	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.0	0.0	0.0	0.0	2.430	0.0
DI	1.1	0.1	0.9	1.309	0.0	0.0
FO	0.9	1.3	0.8	0.554	0.0	0.830
FA	2.5	4.4	4.1	0.843	0.0	1.915
NE	2.4	7.4	5.9	3.651	0.0	5.885
LC	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0
HE	2.4	0.3	3.4	1.576	0.0	0.0
CC	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Ref. No.	Sample No.	Ref. No.	Sample No.
1492	NAG4 575-600	1549	N4 64-575B
1514	NAG C	1552	H8 442
1513	NAG D	1554	H8 520

TABLE A-4. CONTINUED.

	Medium-grained Syenite					Nepheline-bearing Syenite	
Ref. No.	**1498**	**1490**	**1510**	**1550**	**1516**	**1486**	**1507**
AP	0.4	0.3	0.4	0.442	0.4	0.3	0.2
PO	0.0	0.0	0.0	0.028	0.0	0.0	0.1
IL	1.6	1.9	1.9	1.715	1.9	1.3	1.0
OR	30.2	30.8	30.7	29.558	30.1	38.7	40.0
AB	41.2	43.9	43.2	42.009	45.6	33.7	36.6
AN	7.5	6.1	5.9	11.048	5.9	7.8	8.0
C	0.0	0.0	0.0	1.651	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	3.4	3.7	3.6	6.460	3.6	3.2	3.0
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	0.4	1.3	1.2	0.0	1.3	1.6	0.7
FO	0.9	0.9	1.1	1.576	1.0	1.7	0.9
FA	5.5	2.8	4.0	1.640	3.4	4.6	3.4
NE	7.1	5.2	4.6	3.872	3.1	3.3	4.0
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	1.8	3.2	3.4	0.0	3.5	3.5	2.1
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Ref. No.	Sample No.	Ref. No.	Sample No.
1498	NAG4 600-625	1516	NAG4 775-800B
1490	NAG4 725-750	1486	NAG9 300-325A
1510	NAG4 750-775	1507	NAG9 300-325B
1550	N4 64-575A		

TABLE A-4. CONTINUED.

	Nepheline-bearing Syenite			Miscellaneous		
Ref. No.	1555	1491	1556	1489	1496	1488
AP	0.143	0.2	0.306	0.0	0.0	0.0
PO	0.057	0.1	0.028	0.1	0.1	0.0
IL	0.881	0.9	1.118	0.5	0.2	0.3
OR	33.599	38.3	37.589	34.2	30.8	34.0
AB	36.893	37.7	33.147	44.7	32.1	48.9
AN	10.736	7.4	6.536	3.1	8.2	6.0
C	0.0	0.0	0.0	0.0	3.8	0.6
AC	0.0	0.0	0.0	0.0	0.0	0.0
MT	4.828	2.9	4.357	2.6	0.1	2.4
HM	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0
EN	0.0	0.0	0.0	0.0	0.6	0.0
FS	0.0	0.0	0.0	0.0	1.9	0.0
Q	0.0	0.0	0.0	0.0	22.2	0.0
DI	0.438	0.6	1.945	0.3	0.0	0.0
FO	1.405	1.0	1.281	0.3	0.0	0.4
FA	4.101	4.0	2.224	3.6	0.0	2.1
NE	5.907	5.1	8.797	7.0	0.0	5.2
LC	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0
HE	1.012	2.0	2.671	3.5	0.0	0.0
CC	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Ref. No.	Sample No.	Ref. No.	Sample No.
1555	H9 335	1489	NAG8 550-575
1491	NAG B	1496	NAG6 575-590
1556	H9 390	1488	NAG E

TABLE A-4. CONTINUED.

			Trachytoid Coarse-grained Syenite				
Ref. No.	**1499**	**1500**	**1505**	**1504**	**1503**	**1553**	**1497**
AP	0.1	0.3	0.4	0.4	1.3	0.071	0.4
PO	0.0	0.2	0.2	0.3	0.6	0.084	0.0
IL	1.0	1.4	3.9	2.0	4.7	1.620	2.3
OR	33.5	25.4	25.2	21.8	20.1	30.269	31.7
AB	48.3	35.7	35.3	30.8	25.2	34.721	41.8
AN	5.1	8.1	8.6	4.2	6.2	9.179	6.9
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	2.2	3.3	5.2	3.8	5.8	5.962	3.9
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	0.8	0.0	0.0	0.0	0.0	0.0	0.0
FS	4.3	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.8	0.0	0.0	0.0	0.0	0.0	0.0
DI	0.7	4.7	2.3	7.0	3.0	0.526	1.2
FO	0.0	0.8	1.0	0.7	1.5	0.432	1.1
FA	0.0	3.1	5.2	2.9	10.1	4.869	3.7
NE	0.0	3.4	3.8	3.3	5.9	7.577	3.9
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	3.2	13.7	9.0	22.7	15.6	4.691	3.1
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Ref. No.	Sample No.	Ref. No.	Sample No.
1499	NAG7 775-800B	1503	NAG H
1500	NAG7 775-800A	1553	H8-500
1505	NAG A	1497	NAG4 625-650
1504	NAG G		

TABLE A-4. CONTINUED.

	Melanocratic Syenite					
Ref. No.	1494	1495	1512	1506	1517	1551
AP	1.8	1.1	0.3	0.9	4.4	0.913
PO	0.2	0.1	0.2	0.3	0.2	0.304
IL	3.0	2.0	1.9	2.8	13.2	2.741
OR	18.3	24.7	28.0	25.9	0.3	24.417
AB	44.1	45.6	40.7	36.5	0.0	32.075
AN	15.0	7.6	7.6	5.8	5.1	14.685
C	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0
MT	2.8	2.7	3.6	4.3	12.3	4.785
HM	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0
EN	0.0	0.0	0.0	0.0	0.0	0.0
FS	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.0	0.0	0.0	0.0	0.0	0.0
DI	1.8	2.0	2.9	3.3	3.2	1.433
FO	2.5	1.5	0.8	1.4	2.6	2.141
FA	6.0	5.3	2.8	4.8	22.0	6.455
NE	1.1	1.8	2.8	4.8	10.0	6.633
LC	0.0	0.0	0.0	0.0	5.4	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0
HE	3.4	5.4	8.4	9.0	21.2	3.417
CC	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Ref. No.	Sample No.	Ref. No.	Sample No.
1494	NAG7 750-775	1506	NAG F
1495	NAG7 800-812	1517	NAG4 775-800A
1512	NAG5 525-550	1551	N5-64

TABLE A-5. AVERAGE CHEMICAL COMPOSITIONS* (WEIGHT PERCENT AND PPM) OF LITHOLOGIC UNITS FOR THE NAGAGAMI RIVER ALKALIC ROCK COMPLEX.

	Coarse-grained Syenite (N = 14)		Medium-grained Syenite (N = 5)	
	Mean	Std. Deviation	Mean	Std. Deviation
SiO_2	54.69	5.89	56.82	0.86
Al_2O_3	18.32	2.87	18.42	1.32
Fe_2O_3	5.62	4.80	3.97	0.55
FeO	4.43	3.26	4.06	0.32
MgO	0.79	0.29	0.66	0.19
CaO	2.27	0.71	2.41	0.12
Na_2O	5.37	1.02	6.07	0.22
K_2O	5.38	0.92	5.06	0.06
TiO_2	1.02	0.96	0.93	0.06
P_2O_5	0.13	0.10	0.17	0.03
MnO	0.18	0.09	0.14	0.01
CO_2	0.72	0.38	0.70	0.32
S	0.09	0.07	0.01	0.00
H_2O+	0.24	0.31	0.14	0.09
H_2O-	0.44	0.26	0.42	0.09
LOI	1.14	0.84	0.82	0.16
TOTAL	99.89	0.62	100.04	0.87
S.G.	2.00	1.32	2.17	1.21
Ag	<1.17	0.39	<1.20	0.45
Ba	668.33	380.19	374.00	65.04
Co	<4.08	3.18	<3.00	4.47
Cr	<0.33	5.79	<2.40	5.81
Cu	14.58	6.87	<2.80	4.92
Li	21.42	13.32	19.80	7.89
Ni	<5.00	0.00	<5.00	0.00
Pb	14.83	8.43	10.60	11.59
Zn	163.75	97.64	115.40	18.16
Be	2.67	1.23	1.40	0.55
Mo	<0.92	4.93	<2.80	4.02
Sc	8.50	11.81	20.00	3.54
Sr	136.33	101.27	0.00	82.46
V	<10.00	0.00	<10.00	0.00
Y	53.21	18.67	22.00	20.19
Ga	42.62	11.21	25.40	3.91
Nb	231.43	159.56	46.00	47.22
Rb	176.43	95.16	104.00	11.40
Zr	360.00	231.90	102.50	33.04
Sn	5.08	7.61	1.20	0.45
Eu	<100.00	0.00	<100.00	0.00
Yb	4.29	2.89	1.20	0.45
Ce	297.14	283.91	86.00	25.10
La	82.14	294.57	<100.00	0.00
Nd	<3.57	208.61	<24.00	154.37

*The average compositions may include duplicate samples or analyses which are not listed in Tables A-2 to A-4.

TABLE A-5 . CONTINUED.

	Nepheline-bearing Syenite (N = 6)		Miscellaneous Rocks (N = 3)	
	Mean	Std. Deviation	Mean	Std. Deviation
SiO_2	56.45	1.23	62.70	4.37
Al_2O_3	18.17	0.69	19.03	1.27
Fe_2O_3	3.02	0.43	2.10	1.89
FeO	4.20	0.40	1.86	0.81
MgO	0.95	0.27	0.22	0.02
CaO	2.57	0.29	1.44	0.20
Na_2O	5.21	0.43	5.78	1.79
K_2O	6.25	0.38	5.52	0.35
TiO_2	0.55	0.10	0.19	0.09
P_2O_5	0.11	0.03	0.00	0.00
MnO	0.17	0.02	0.05	0.02
CO_2	1.13	0.38	0.45	0.44
S	0.02	0.02	0.02	0.01
H_2O+	0.67	0.18	0.23	0.20
H_2O-	0.36	0.15	0.27	0.19
LOI	1.87	0.66	1.10	0.44
TOTAL	99.83	0.41	99.83	1.02
S.G.	1.79	1.39	2.57	0.05
Ag	<1.33	0.52	<1.00	0.00
Ba	1316.67	393.18	126.67	55.08
Co	<5.00	0.00	<5.00	0.00
Cr	<5.00	0.00	<1.67	5.77
Cu	9.67	2.94	<5.00	0.00
Li	31.67	5.85	23.33	20.50
Ni	<5.00	0.00	<5.00	0.00
Pb	12.33	11.29	6.00	14.42
Zn	143.83	19.54	45.00	2.65
Be	3.40	1.14	4.33	4.93
Mo	<0.17	7.39	<1.00	0.00
Sc	9.00	3.29	<5.00	0.00
Sr	212.50	68.54	<60.00	0.00
V	<10.00	0.00	<10.00	0.00
Y	73.33	8.16	53.33	23.09
Ga	33.20	6.65	49.67	6.03
Nb	425.00	103.68	233.33	104.08
Rb	178.33	30.61	346.67	30.55
Zr	625.00	95.74	140.00	115.33
Sn	12.40	21.03	3.67	3.79
Eu	<100.00	0.00		
Yb	7.50	2.81	2.67	6.35
Ce	380.00	101.00	206.67	20.82
La	241.67	86.12	<16.67	144.34
Nd	<1.67	231.29	63.33	5.77

TABLE A-5 . CONTINUED.

	Trachytoid Coarse-grained Syenite (N = 8)		Melanocratic Syenite (N = 7)	
	Mean	Std. Deviation	Mean	Std. Deviation
SiO_2	54.88	3.99	51.06	10.07
Al_2O_3	15.68	2.08	15.39	3.97
Fe_2O_3	3.88	2.05	5.09	6.55
FeO	7.56	2.61	8.99	4.94
MgO	1.05	0.48	1.40	0.40
CaO	4.80	2.11	5.11	1.75
Na_2O	5.04	0.60	4.91	1.23
K_2O	4.47	0.79	3.73	1.25
TiO_2	1.19	0.69	2.03	2.11
P_2O_5	0.17	0.16	0.60	0.60
MnO	0.27	0.10	0.28	0.18
CO_2	0.48	0.16	0.48	0.19
S	0.07	0.07	0.08	0.03
H_2O+	0.13	0.16	0.17	0.08
H_2O-	0.26	0.12	0.35	0.11
LOI	0.24	0.24	0.11	0.53
TOTAL	99.90	0.56	99.66	0.48
S.G.	2.51	1.02	2.50	1.15
Ag	<1.12	0.35	<1.14	0.38
Ba	637.50	292.51	1415.71	855.55
Co	<0.87	5.72	5.57	5.22
Cr	<0.50	6.37	<0.43	5.71
Cu	10.62	11.39	15.71	4.64
Li	15.37	6.16	21.29	10.78
Ni	<5.00	0.00	<5.00	0.00
Pb	8.50	11.64	12.57	17.84
Zn	179.00	66.61	225.43	151.19
Be	2.29	1.25	3.33	4.27
Mo	1.00	6.02	<1.57	3.91
Sc	26.87	19.63	30.71	17.90
Sr	124.37	135.58	347.14	250.38
V	<10.00	0.00	<5.00	12.25
Y	48.75	24.89	106.43	108.42
Ga	33.57	3.95	36.17	9.58
Nb	181.25	188.71	291.43	163.85
Rb	110.00	49.86	82.86	44.24
Zr	311.43	167.08	900.00	1521.84
Sn	2.43	1.62	3.67	3.61
Eu	<100.00	0.00	<100.00	0.00
Yb	5.25	3.41	8.86	9.65
Ce	255.00	188.15	438.57	291.51
La	25.00	190.86	178.57	326.42
Nd	45.00	143.83	112.86	211.01

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